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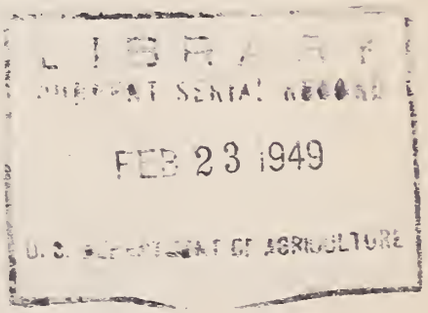
UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1948

Part I

Work Conducted by State Agencies,
Entomological Branch, Canadian Department of
Agriculture and Commonwealth of Australia



Not for Publication

This pool of information on the results of codling moth research for the season of 1948 is the sixteenth of a series of similar summaries prepared by the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, at the request of the Committee on the Codling Moth of the American Association of Economic Entomologists. These data are assembled for the confidential information of workers who are interested in the codling moth problem. The material is not for publication and is therefore not available for quotation or other use without specific permission from the agency which has furnished it.

Because of the general interest in pest control problems arising from the use of DDT for codling moth control in apple orchards and their close relationship to the codling moth spray program, information is included on such problems in this pool of information. The more important such problem pests at the moment include orchard mites, red-banded leaf roller and the woolly apple aphid. The San Jose and Forbes' scales are also increasing in importance in DDT sprayed orchards in some areas.

CALIFORNIA

A. E. Michelbacher and W. W. Middlekauff, University of California, Berkeley.

Control of Codling Moth on Payne Variety of Walnut in Northern California

Investigations at Linden and at San Jose have clearly demonstrated that standard lead arsenate is much more effective against the codling moth than is basic lead arsenate. A single early spray of the former at the rate of 3 pounds to the 100 gallons of spray has proved to be about as effective as a two-spray program of basic lead arsenate used at the rate of 4 pounds per 100 gallons.

The addition of a basic zinc sulfate safener (Delmo Z) to the standard lead arsenate spray did not reduce the effectiveness of the material. Although a single spray of standard lead arsenate gives good control, everything possible should be done to increase its effectiveness. Investigations during the past two seasons indicate that the addition of a depositor to the spray mixture increases the deposit and improves the control obtained.

It appears that the addition of a depositor to the standard lead arsenate spray is desirable, and if one is added the manufacturer's recommendations should be carefully followed.

DDT has resulted in excellent control of the codling moth. At Linden an early spray containing 1/2 pound of actual DDT per 100 gallons of water has resulted in slightly better control than that obtained with a single spray of standard lead arsenate. At San Jose the above spray programs resulted in about equal control.

Investigations have shown that 1/2 pound of actual DDT per 100 gallons of spray is less likely to result in the development of a destructive orchard mite population than higher dosages. However, even at this lower amount there is some danger of serious infestations occurring. Until a highly satisfactory method for controlling mites can be developed, DDT cannot be safely recommended for the control of the codling moth. The danger of causing an increase in the orchard mite population appears to be the last obstacle that needs to be removed before this insecticide can be recommended without several reservations. Means of eliminating the increase in the walnut aphid and frosted scale populations following applications of DDT have been developed. It is hoped that a spray program might be devised whereby DDT and standard lead arsenate can be used in alternate years or alternated the same year where two sprays may be necessary to insure satisfactory control. It is also possible that 1/2 pound of a 50 percent wettable DDT powder can be safely added to the regular standard lead arsenate spray. However, if a grower cares to apply DDT he should not use it at a dosage of more than 1 pound of a 50 percent wettable powder to the 100 gallons of spray and then always in combination with an aphicide.

Based on extensive investigations for two seasons it appears that the addition of an aphicide to the early codling moth spray is a worth while procedure. The addition of one pound of a 14 percent dry nicotine concentrate, or 2/3 pound of benzene hexachloride containing 10 percent gamma isomer, or 1/3 of 25 percent parathion, or 1/4 pint of tetraethyl pyrophosphate all resulted in very satisfactory control of the walnut aphid. Because the dry nicotine concentrate is likely to have less adverse effect upon predators than the new insecticides, it probably is the safest material to recommend until the others have further stood the test of time.

There are no reports where standard lead arsenate used with or without a safener has caused any injury to walnuts in northern California. Because investigations have shown it to be much more effective than basic lead arsenate, it appears that unlimited recommendations for its use can be safely made. However, to insure satisfactory control, thoroughness of application is necessary.

Tests to determine the desirability of using a speed sprayer for the application of codling moth sprays were undertaken in 1948. The results obtained looked promising. From these preliminary investigations it appears that a desirable dosage on large trees is around 22 gallons per tree of a spray mixture containing 6 pounds of standard lead arsenate or 2 pounds of a 50 percent wettable DDT powder to each 100 gallons of spray. At this rate the amount of insecticide applied per tree was 1.32 pounds of standard lead arsenate, or 0.43 pounds of DDT as compared to 1.65 pounds of standard lead arsenate or 0.55 pounds of DDT applied per tree where applications were made with a conventional sprayer (conventional spray mixture containing 3 pounds standard lead arsenate or 1 pound 50 percent wettable DDT and applied at the rate of 55 gallons per tree). However, further investigations are necessary before definite recommendations can be made concerning the use of speed sprayers.

The investigations during the past two seasons have shown that the first brood of codling moth was much later in getting under way at San Jose than at Linden. Further, the infestations at San Jose do not appear to be as serious as those that are likely to be encountered at Linden. The trends of the infestations in the check trees during the growth of the nuts for 1947 and 1948 in the experimental orchard at Linden and at San Jose are plotted in Figure 1. This clearly shows the differences that exist between the two regions. At Linden the first brood was later in getting started than in any year since the investigation was undertaken in 1942. In 1947 it was somewhat earlier than usual, when two percent of the nuts were found infested on May 1. In this region first brood caterpillars do not usually begin entering nuts until the first to the tenth of May. It is obvious that the infestation starts much later in the San Jose area. Here it appears that nuts are not likely to be infested before May 15 to June 1.

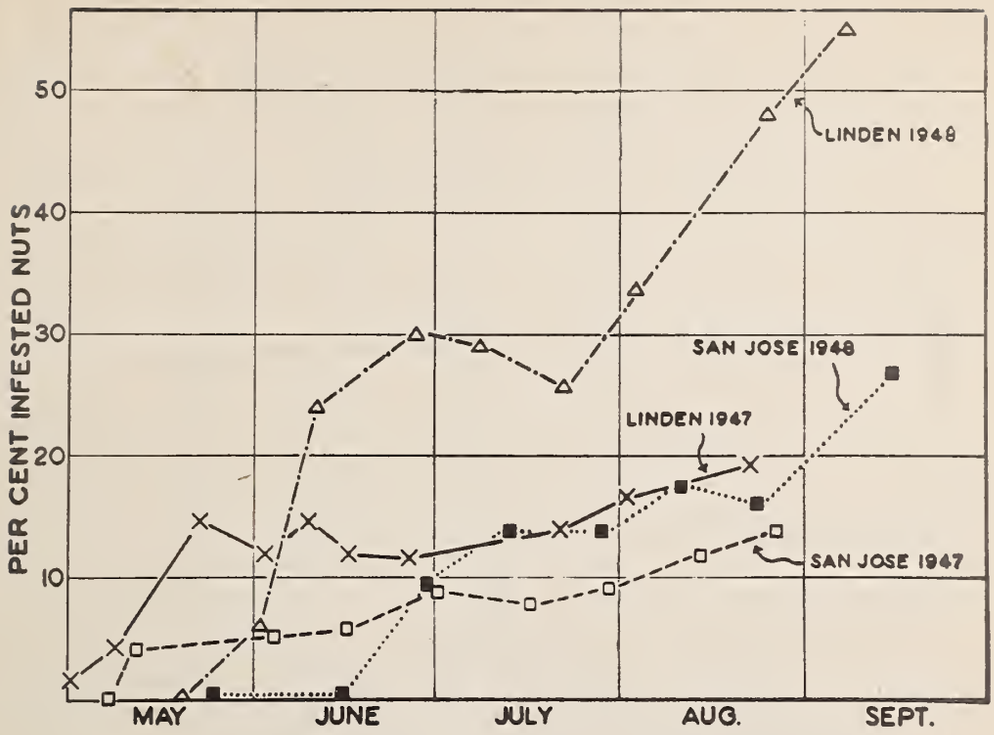


Fig. 1.--Seasonal trend of infestation in the maturing nut crop in the check plots at Linden and at San Jose for the years of 1947 and 1948.

Therefore, the time to apply the codling moth spray will be considerably later at San Jose than at Linden. The average date for applying the spray at Linden would be about May 5, while at San Jose it appears that there would be no need to apply a spray before May 20 at the earliest.

The absence of a first brood of caterpillars developing in the orchard at Campbell in the San Jose area creates a rather difficult problem. There is some evidence to indicate that moths migrated into the walnuts after the first brood developed in adjacent apricots. Certainly, if an infestation is going to result from migrating moths which developed on another crop, there is no need of applying a spray in May. The application could safely be delayed until after June 15, and an examination of Figure 2 well illustrates this point. The question is, "How frequently is the above condition encountered?"

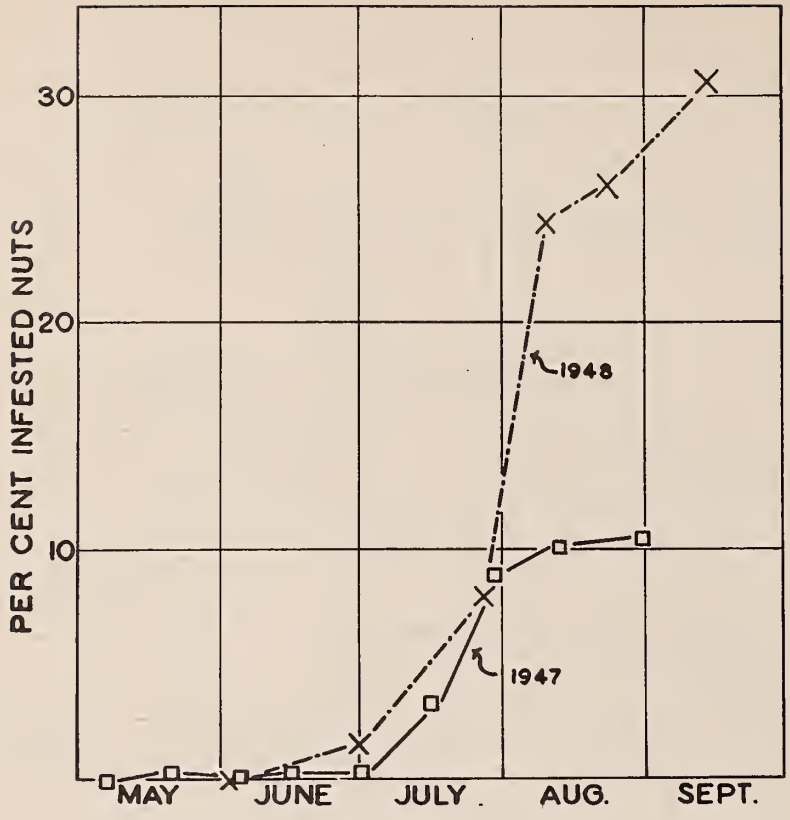


Fig. 2.--Seasonal trend of infestation in the maturing nut crop in the check plot at Campbell for the years 1947 and 1948.

Figure 3 has been prepared to illustrate the value of codling moth control. Shown are the average number of good nuts, infested nuts, and culls other than infested per tree that were harvested from the different treatments in the single tree plot replicated experiment at Linden. A glance at the figure shows that all of the treatments out-yielded the check by a very wide margin.

Throughout all of northern California the codling moth infestation in 1948 was much more serious than that encountered in any recent year. The cause of this is not known although it may in part have been associated with the lateness of the season. This not only gave rise to a late first brood but also resulted in the second brood occurring late in the summer. At Linden some nuts were being infested almost up to harvest, and at harvest time an occasional adult moth was encountered, which is certainly an unusual occurrence for late September.

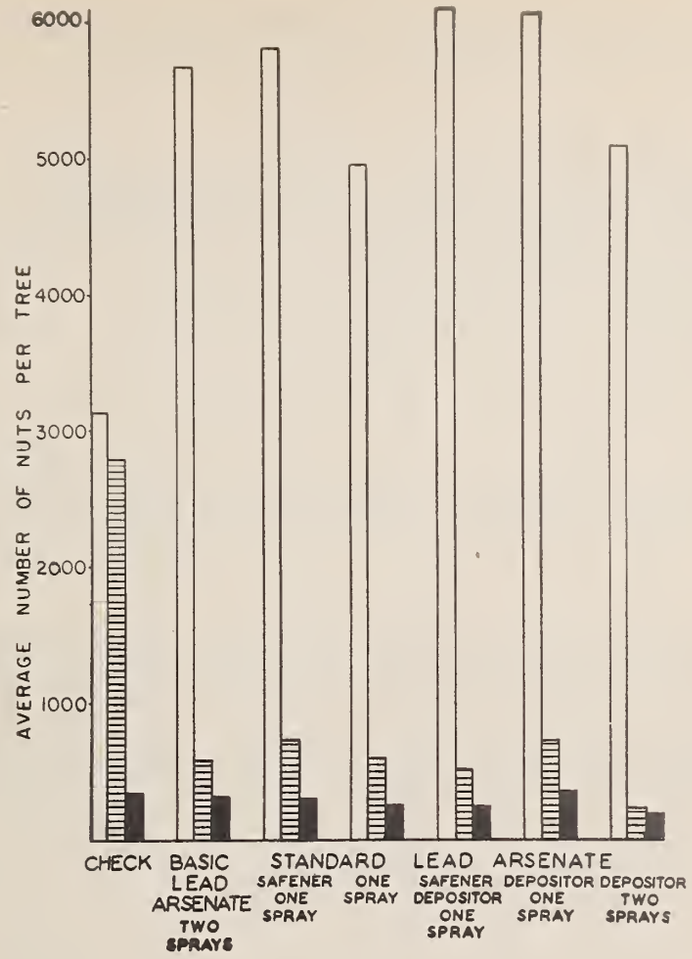


Fig. 3.--Average number of harvested nuts per tree classified as good, infested, and culls other than infested. Open bar, good; horizontal hatched bar, infested; solid bar, culls other than infested nuts.

One properly applied spray in May before the first brood of caterpillars begins to enter the nuts has generally resulted in satisfactory control. A second spray applied during the second half of June will improve the control, but it appears that the added benefit obtained in many instances would not justify the cost of treatment. However, where serious infestations were encountered in 1948, a two-spray program should be followed in 1949 to insure highly desirable results.

At the present time it appears that the most satisfactory spray that can be recommended for general use is as follows:

Standard lead arsenate	3 pounds
Safener (Delmo Z, a commercial basic zinc sulfate product containing 50 percent zinc expressed as metallic, or a similar product)	1 pound
14 percent nicotine dry concentrate	1 pound
Light medium summer oil emulsion containing 83 percent oil	1/3 gallon
Water	100 gallons

Order of mixing: Slurry the nicotine, then add standard lead arsenate, safener, and continue to slurry. Add slurried ingredients to spray tank with agitator going when 1/3 to 1/2 full, followed by the oil when tank is 3/4 or more full.

If desired, 1/4 to 1/3 pound of a depositor can be added to the above spray. It should be slurried with the dry ingredients.

Other aphicides that have shown promise at the following rates per 100 gallons of spray are the following: Benzene hexachloride containing 10 percent gamma isomer, 2/3 pounds or 25 percent parathion wettable powder 1/3 pound, or tetraethyl pyrophosphate 1/4 pint. If the latter is used it should be added to the spray tank just as it becomes full.

The following DDT spray is given for growers who would like to use this insecticide on a limited acreage:

50 percent DDT wettable powder	1 pound
DDT depositor	1/3 pound
14 percent dry nicotine concentrate	1 pound
Light medium summer oil emulsion containing 83 percent oil	1/3 gallon
Water	100 gallons

Order of mixing: DDT and depositor slurried together, nicotine slurried separately, the former added to tank with agitator going when tank is 1/3 to 1/2 full followed by the nicotine and then the oil.

To avoid a serious increase in the walnut aphid population, an aphicide should always be added to DDT sprays. In order that the advantage of DDT may be utilized and its disadvantage held to a minimum, it is recommended that if DDT is used, standard lead arsenate should be used in alternate years.

CALIFORNIA (Continued)

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SCOPE

Investigations relating to the control of codling moth, Carpocapsa pomonella (Linn.), on apples and pears have included studies of the most effective use of DDT by varying the number of cover sprays, the volume of spray, and the amount of DDT applied per acre. In seasonal schedules on apples, the effect of various additives of potential value in stabilizing deposits of DDT was investigated. Comparative studies of the effectiveness of parathion, ditolyl trichloroethane and DDT were conducted by various seasonal schedules on apples and pears.

Exploratory trials were implemented concerning the removal of parathion residues from pears and apples.

Orchard comparisons of acaricides were usually effected by inclusion of these in regularly scheduled codling moth cover sprays in apple orchards infested with European red mite, Paratetranychus pilosus (C & F), two-spotted mite, Tetranychus bimaculatus Harvey, or clover mite, Bryobia praetiosa Koch., and in pear orchards infested with Pacific mite, Tetranychus pacificus McG.

METHODS

Data on codling moth are based on an integration of records from all dropped fruits, a sample of 300 harvested fruits except where otherwise indicated, and a count of the remaining harvested fruits--the final figure representing injury to the total crop.

In this area, Pacific mite injury is manifested by defoliation and develops from relatively low populations of mites which are not uniformly distributed over the tree. This results in the development of blasted areas on the tree. Efficiency comparisons are usually made by visually rating the degree of injury, as described in the tabular footnotes.

Chemical analyses reported herein were made by Dr. Francis A. Gunther and his associates. Analyses for DDT were made by the dehydrohalogenation method. For parathion, analyses were made by the colorimetric method developed by the American Cyanamid Company. To avoid contamination by surface residues, the material used for the penetration analyses was obtained by splitting the fruits and removing the previously untouched pulp with a melon baller. A blank correction was provided for all analyses.

CODLING MOTH CONTROL EXPERIMENTS

Rome Beauty apples -- Oak Glen: Comparison of toxicants, stabilization of DDT deposits.

In a schedule of four cover applications applied at intervals of three to four weeks to single tree plots replicated in eight blocks in an orchard in which the untreated trees averaged 45 entries per one hundred fruits,

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1/ Assisted by C. L. Turzan, Senior Laboratory Technician.

comparisons were made among six programs of wettable powders of DDT, ditolyl trichloroethane, and parathion. As indicated in Table 1, ditolyl trichloroethane did not provide adequate control of codling moth. It had no appreciable effect upon clover mite in the schedule applied. Confirming results in 1947, parathion showed definite value for codling moth control in this trial, two and four ounces of actual parathion per one hundred gallons providing control of entrances equivalent to four ounces of DDT and approaching the control of stings provided by the latter within one per cent. A contributory effect on codling moth control is also indicated where one ounce of parathion supplemented each spray of four ounces of DDT per one hundred gallons. Each parathion schedule almost completely suppressed populations of the clover mite, which developed to injurious levels on trees sprayed with DDT. Parathion residue data from these programs are presented in Table 11, Nos. 1, 2, and 3.

Trees in this orchard which received four applications of parathion at 2.4 ounces per one hundred gallons in 1947 and which were sprayed with DDT this year, developed populations of the clover mite about ten weeks later than trees sprayed with DDT in both 1947 and 1948, and which had commercial control of clover mite in 1947 by an application of DN-111.

Also replicated in this trial were comparisons among several additives to DDT sprays for the purpose of stabilizing the resultant deposits. These included glycerine, glycerol dichlorhydrin, carboxy methyl cellulose, and a phenyl biguanide salt. The low level of infestation of fruits sprayed with DDT alone was not conducive to significant comparisons of the value of the additives.

In a second Rome Beauty orchard with a high codling moth infestation carrying over from 1947, a schedule of three cover sprays was applied with a speed sprayer to three acre plots having a minimum plot width of sixty yards. As indicated by Table 2, parathion at two ounces was not so effective as DDT at eight ounces per one hundred gallons. An improvement in control would have resulted from the application of a fourth cover spray as in the preceding trial. As applied, however, this schedule affords evidence of the greater vulnerability of parathion deposits as compared with DDT in the dosages indicated and with an extended weathering period permitted in a severe infestation. Immediately before the third cover spray, 76 per cent of the terminals in the DDT block and 4 per cent in the parathion block bore small colonies of the woolly apple aphid, Eriosoma lanigerum (Hausm.).

Delicious apples -- Oak Glen: Reduction in number of cover sprays for control of an attenuated codling moth population.

The program of one, two, and three cover sprays described in Table 3 was applied to three acre plots with a minimum width of one hundred yards in an orchard in which less than one-half per cent entered fruit was present in 1947. These programs maintained excellent control.

Delicious apples -- Julian: A comparison among semi-concentrate applications of DDT applied with a speed sprayer

As described in Table 4, applications were made in three cover sprays at one, two, and four hundred gallons per acre to two and one-half acre plots with a minimum plot width of 70 yards. The rate of DDT per acre was also varied as described. Data from untreated trees in the same orchard and immediately adjacent to the plots indicated an infestation of 14 entries per one hundred fruits. Excellent codling moth control was attained in all schedules.

Bartlett pears -- Antelope Valley: Comparison of toxicants.

Various dosages of parathion were applied in comparison with DDT and ditolyl trichloroethane in four applications at intervals of three to five weeks in an orchard in which untreated trees averaged 16 entries per one hundred fruits at harvest. Ditolyl trichloroethane did not provide adequate control as shown by data in Table 5. Parathion at four and eight ounces provided control of entrances equivalent or better than that provided by four and eight ounces of DDT per one hundred gallons in this relatively light infestation. Parathion at two ounces was equivalent or better than four ounces of DDT per one hundred gallons. Residues of parathion resulting from the above programs are shown in Table 12, Nos. 2, 3, and 4, together with pertinent time intervals and mean daily temperatures.

A second trial was conducted in a Bartlett pear orchard in which codling moth injury had been reduced to less than one per cent by application of DDT in 1947. Four cover sprays of two ounces of actual parathion per one hundred gallons were applied in a two acre plot with a vertical, fixed nozzle spray boom and in comparison with eight ounces of actual DDT applied in the same schedule in the remainder of the orchard. As indicated by data in Table 6, excellent codling moth control was maintained by these programs. Results of parathion residue studies in this trial are reported in Table 12, No. 6.

Bartlett pears -- Antelope Valley: Reduction in number of cover sprays for control of an attenuated codling moth population

In 1947, reduced programs for codling moth control on Bartlett pears were successful on an experimental basis. The trial conducted in 1948 is reported in Table 7 and was implemented by three acre plots with a minimum plot width of 70 yards. Applications were made with a fixed nozzle vertical boom. There was some larval activity during the harvest period in the reduced programs in this trial. Only a small percentage of fruits were affected, but indications were that had the harvest period been extended, considerable injury might have resulted.

EUROPEAN RED MITE, TWO-SPOTTED MITE AND CLOVER MITE CONTROL EXPERIMENTS

Delicious apples -- Ventura: Comparison of acaricides

In an orchard infested with European red mite, two-spotted mite, and clover mite, eighteen varied schedules were applied to single tree plots replicated in five blocks and to additional plots of ten trees each. These

schedules were preventive and are presented in Table 8 together with control data. Parathion residue data from this trial is presented in Table 11, Nos. 6, 7, 8, and 9.

Parathion and di(p-chlorophenyl) methyl carbinol (DMC) were outstanding in the control of all three species of mites. With the solution of DMC, some necrosis of the epidermal cells, corresponding to droplet formation on the lower sides of the leaves only, was observed on August 4 on 7 per cent of leaves from schedule No. 12 and 30 per cent of leaves from schedule No. 13.

As employed in this trial, several of the other materials exerted a selective action. Di(p-chlorophenoxy) methane (K-1875) was effective in the preventive schedules described for European red mite and two-spotted mite but did not control clover mite. This material russeted 70 per cent of fruits in schedule No. 10 and 100 per cent of fruits in schedule No. 11. At the lower dosage "lorol"-2-thiazolinyl sulfide (IN-4200) was also less effective against clover mite than for the other species. Di(x-chlorophenyl) ethane (K-3926) was more effective against two-spotted mite than the two other species. At the dosage used, DN-111 was very much more effective for clover mite than for the other species. Chlorinated camphene did not provide adequate control as used in this trial.

Rome Beauty apples -- Oak Glen: Comparison of acaricides.

A comparison of materials for clover mite control was implemented by supplementing regularly scheduled cover sprays with these as described in Table 9. In a relatively light infestation, K-1875 and IN-4200 were not effective in preventive schedules for clover mite control. DMC and DN-111 afforded excellent control. No injury occurred on fruit and foliage of these plots. The analyses of DDT residues at harvest presented in Table 9 indicate that surface loads were higher when either IN-4200 or a solution of DMC was used as the acaricidal adjuvant.

Delicious apples -- Julian: A trial of semi-concentrate sprays

Parathion was applied in the manner described in Table 4, involving reduced rates of application per acre with a speed sprayer. These programs did not provide material corrective control of a severe infestation of two-spotted mite and indicate that parathion should be used at higher concentrations in similar future trials. Parathion residue data from this trial are presented in Table 11, Nos. 10, 11, 12, and 13.

Delicious apples -- Julian: A trial of materials

In an infestation of two-spotted mite, application was made with a speed sprayer of DN-111, IN-4200, and wettable powders of "lorol"-2-thiazolinyl sulfide, K-1875, parathion and a dinitro capryl phenyl crotonate (Rohm & Haas Company Cr-1639). The rapid decline of mite populations on untreated trees was not conducive to significant comparisons among materials. None of the materials caused apparent injury to fruit or foliage.

PACIFIC MITE CONTROL EXPERIMENTS
Bartlett pears -- Antelope Valley

In the orchards treated seasonally for codling moth control, it was noted that where parathion was used at two ounces per one hundred gallons, injury from Pacific mite began to develop after a post-application interval of two to three weeks. Immediately after application of the above spray, the average residue on pear leaves was 0.16 micrograms per square centimeter. After 17 days during which the mean daily temperature was 81°F. this residue was reduced to 0.04 Mg/cm^2. From this limited series of data it is tentatively stated that residues on the order of 0.1 Mg/cm^2 will be required to maintain control of Pacific mite.

Applications specifically for Pacific mite control were made to single tree plots replicated in seven blocks by variously including IN-4200, K-1875, K-3926, DN-111, and parathion in the third cover sprays of one-half pound actual DDT per one hundred gallons and as a special mite spray three weeks later. Failure of an infestation to develop on check trees prevented valid comparisons of control efficiency. As applied, IN-4200 at one pint per one hundred gallons caused injury to the epidermal cells of the fruit. Parathion residue studies from the trial are presented in Table 12, No. 1.

Two applications of DN-111, K-1875, TEPP, and parathion were made at intervals of three weeks to one-half acre unreplicated plots. Comparisons among treatments are presented in Table 10. At least three ounces of parathion will apparently be required if the usual three-week interval between applications is retained. Parathion residues are given in Table 12, No. 5.

Two applications of semi-concentrates at intervals of four weeks were made with a citrus spray-duster at the rate of 200 gallons per acre to one-half acre plots. Included were DN-111 at one pound, IN-4200 at one quart, and parathion at eight ounces per one hundred gallons. These schedules did not provide adequate control of Pacific mite. Parathion residue data are presented in Table 12, No. 7.

A single application of three dosages of parathion, and one each of IN-4200, DN-111, K-3926, and K-1875 was made to one acre plots with a speed sprayer. Significant comparative performance data were not available because of the low level of the infestation which ensued. IN-4200 caused injury to the fruits, chiefly at the drip point. Parathion residue data are shown in Table 12, Nos. 8, 9, and 10.

Ten days before harvest four formulations of IN-4200, varying in the process used to remove lauryl chloride from the "lorol"-2-thiazolinyl sulfide before formulation, were applied to Bartlett pears at the rate of one pint per hundred gallons. These included caustic washed, vacuum topped, water washed and crude "lorol"-2-thiazolinyl sulfide. All formulations caused injury to the fruits.

PARATHION RESIDUE STUDIES AND RESIDUE REMOVAL TRIALS

Investigations with regard to the fate of parathion residues on apple and pear fruits are summarized in Tables 11 and 12. At harvest, parathion surface residues were less than .08 p.p.m. in each of thirteen experimental

schedules on apples and ten on pears. Intervals between the terminal application and harvest ranged from 7 to 70 days. With the standard dosages used in 1948, no parathion was found in the pulp of apple or pear fruits sampled at harvest and at various times during the season. Low level surface residues on apples were not carried over into juices expressed by anhydraulic cider press. It is suggested that this may be due to a close association of the parathion deposits with the waxlike coating of the fruit.

Satisfactory removal of parathion surface residues on pears and apples was not achieved by eighteen varied washing formulations described in Tables 13 and 14.

Table 1. Codling moth, Rome Beauty apples, Oak Glen, 1948. A comparison among materials and potential DDT stabilizers. [1]

	Toxicants and adjuvants	Toxicant per 100 gallons	Entries per 100 fruits	Stings per 100 fruits
1.	Parathion [2]	2 oz.	2.1	2.7
2.	Parathion	4 oz.	2.2	2.7
3.	DDT [3] Parathion	4 oz. 1 oz.	1.2	1.4
4.	DDT	4 oz.	2.0	1.8
5.	DDT	8 oz.	1.0	1.0
6.	Ditolyl trichloroethane [4]	12 oz.	17.7	4.0
7.	DDT Glycerine	4 oz. 1000 g.	1.8	1.8
8.	DDT Glycerol dichlorohydrin [5]	4 oz. 1000 g.	3.6	1.7
9.	DDT Carboxy methyl cellulose [6]	4 oz. 70 g.	3.1	2.6
10.	DDT Phenyl biguanide [7] MBT Salt	4 oz. 91 g.	1.9	1.1
11.	Untreated (3 trees)		45.3	4.0

[1] Cover sprays applied on June 7, July 8, July 29, and August 23 to single tree plots replicated in eight blocks. Residue studies presented in Table 11, Nos. 1, 2 and 3.

[2] From Thiophos 3422, a wettable powder containing 25 per cent parathion supplied by the American Cyanamid Company.

[3] From Dampo "50", a wettable powder containing 50 per cent DDT supplied by the Stauffer Chemical Company.

[4] From Gy-tol "50", a wettable powder containing 50 per cent ditolyl trichloroethane supplied by the Geigy Company.

[5] Supplied by the Shell Oil Company.

[6] Supplied by the Hercules Powder Company.

[7] Supplied by the American Cyanamid Company. (mercaptobenzothiazole)

Table 2. Codling moth, Rome Beauty apples, Oak Glen, 1948.

A comparison among materials and methods of application.[1]

Toxicant	Toxicant per 100 gallons (toxicant per acre)	Gallons per acre	Entries per 100 fruits	Stings per 100 fruits
Speed Sprayer				
1. DDT[2]	1 lb. (6 lbs.)	600	12.5	4.1
2. DDT	8 oz. (6 lbs.)	1200	8.0	3.0
3. Parathion[3]	2 oz. (1 1/2 lbs.)	1200	20.2	2.9
Conventional sprayer[4]				
4. DDT	8 oz. (6 lbs.)	1200	4.1	0.8

[1] Cover sprays applied on June 7, July 10 and August 3 to three acre plots. DN-111 was applied in the third cover spray in blocks one, two and four at the rate of 3/4 lb. per 100 gallons for mite control.

[2] From Gesarol AK-50, a wettable powder containing 50 per cent DDT supplied by the Geigy Company.

[3] From Thiophos 3422, a wettable powder containing 25 per cent parathion supplied by the American Cyanamid Company.

[4] Tower and ground leads, single guns.

Table 3. Codling moth, Standard Delicious apples, Oak Glen, 1948. A semi-commercial trial involving reduction in number of cover sprays in an orchard with excellent control in 1947.

	Composition and schedule of application[1] (Actual toxicant per 100 gallons)					
	Toxicant	May 27	July 9	August 10	Entries per 100 fruits	Stings per 100 fruits
1.	DDT[2]	2 lbs.	-----	-----	0.3	0
2.	DDT	1 lb.	1 lb.	-----	0	0
3.	DDT	1/2 lb.	1/2 lb.	1/2 lb.	0	0

1/ DN-111 at the rate of 3/4 pound per 100 gallons, in addition to DDT, was applied to block 1 on May 27 and block 2 on July 9.

2/ From Gesarol AK-50, a wettable powder containing 50 per cent DDT supplied by the Geigy Company.

Table 4. Codling moth and two-spotted mite, Delicious apples, Julian, 1948.

A comparison among semi-concentrate sprays applied with a speed sprayer in an orchard requiring 600 gallons per acre for complete coverage.

	Composition and schedule of application (Toxicant per 100 gallons) (Toxicant per acre)			Gallons per acre	Entries per 100 fruits	Stings per 100 fruits	Mite control
	Toxicant	May 26	June 24 [1]	July 23			
1.	DDT [2]	6 lbs. (6 lbs.)	6 lbs. (6 lbs.)	6 lbs. (6 lbs.)	100	0.0	0.0	None of these semi-concentrate sprays of parathion afforded material corrective control of a severe two-spotted mite infestation.
	Parathion [3]			8 oz. (8 oz.)			
2.	DDT	3 lbs. (6 lbs.)	3 lbs. (6 lbs.)	3 lbs. (6 lbs.)	200	0.2	0.1	
	Parathion			4 oz. (8 oz.)			
3.	DDT	2 lbs. (4 lbs.)	2 lbs. (4 lbs.)	2 lbs. (4 lbs.)	200	0.0	0.0	
	Parathion			4 oz. (8 oz.)			
4.	DDT	1 lb. (4 lbs.)	1 lb. (4 lbs.)	1 lb. (4 lbs.)	400	0.1	0.0	
	Parathion			2 oz. (8 oz.)			
5.	Untreated					14.0	1.0	

[1] In addition to DDT, five pounds of wettable sulfur per one hundred gallons was included in this spray for mildew control.

[2] From Persisto 50, a wettable powder containing 50 per cent DDT manufactured by the California Spray-Chemical Corporation.

[3] From Thiophos 3422, a wettable powder containing 25 per cent parathion, supplied by the American Cyanamid Company.

Table 5. Codling moth, Bartlett pears, Antelope Valley, 1948.

A comparison among wettable powders.[1]

	Toxicant	Toxicant per 100 gallons	Entries per 100 fruits	Stings per 100 fruits
1.	Parathion[2]	2 oz.	1.6	0.2
2.	Parathion	4 oz.	0.8	0.3
3.	Parathion	8 oz.	0.4	0.1
4.	DDT[3]	4 oz.	2.0	0.2
5.	DDT	8 oz.	0.9	0.2
6.	Ditolyl trichloroethane[4]	8 oz.	6.9	0.4
7.	Untreated[5]	-----	16.4	1.1

[1] Cover sprays applied on May 5, June 10, July 7, and July 28 to single tree plots replicated in eight blocks. Residue studies presented in Table 12, Nos. 2, 3 and 4.

[2] From Thiophos 3422, a wettable powder containing 25 per cent parathion supplied by the American Cyanamid Company.

[3] From Deenate 50W, a wettable powder containing 50 per cent DDT supplied by the E. I duPont de Nemours & Company.

[4] From Gy-tol "50", a wettable powder containing 50 per cent ditolyl trichloroethane supplied by the Geigy Company.

[5] An average of data from five trees.

Table 6. Codling moth control, Bartlett pears, Antelope Valley, 1948.

A comparison of DDT and parathion wettable powders in a reduced infestation.[1/]

Toxicant	Toxicant per 100 gallons	Entries per 100 fruits	Stings per 100 fruits
1. Parathion[2/]	2 oz.	0.3	0.1
2. DDT[3/]	8 oz.	0.1	0.1

1/ Cover sprays applied on April 28, May 26, June 28 and July 20 to two acre plots.

2/ From Thiophos 3422, a wettable powder containing 25 per cent parathion supplied by the American Cyanamid Company.

3/ From Gesarol AK-50, a wettable powder containing 50 per cent DDT supplied by the Geigy Company, Inc. DN-111 was added at the rate of 3/4 pound per 100 gallons in the 3rd and 4th cover sprays.

Table 7. Codling moth, Bartlett pears, Antelope Valley, 1948.

A semi-commercial trial involving reduction in number of cover sprays.

Composition and schedule of applications[1]					
Toxicant	Actual DDT per 100 gallons (Actual DDT per acre) 1st	2nd	3rd	Entries per 100 fruits	Stings per 100 fruits
	May 5	June 8	July 2		
1. DDT[2]	1 lb. (10 lbs.)	----	----	0.6	0.2
2. DDT	1/2 lb. (5 lbs.)	1/2 lb. (5 lbs.)	----	1.6	0.2
3. DDT	1/2 lb. (5 lbs.)	1/2 lb. (5 lbs.)	1/2 lb. (5 lbs.)	0.5	0.3

[1] Blanket sprays consisting of 3/4 pound DN-111 and 1/3 pound Colloidal Z-1 per 100 gallons were applied on July 2 and July 21 for Pacific mite control in all plots. This material was included with DDT in plot 3 on July 2.

[2] From Gesarol AK-50, a wettable powder containing 50 per cent DDT supplied by the Geigy Company, Inc.

Table 8. Clover mite, European red mite and two-spotted mite, Delicious apples, Ventura, 1948.

A comparison among acaricides

	Toxicant	Composition and schedule of applications (Actual toxicant per 100 gallons)				Mites/100 leaves (% reduction over treatment 14) - Aug. 4		
		1st May 7	2nd June 4	3rd July 1	4th August 5	Clover mite	European red mite	Two-spotted mite
1.	DDT[1]	8 oz.	8 oz.	8 oz.	8 oz.	43 (89)	174 (85)	1,608 (57)
	Parathion[2]		1 oz.	1 oz.	1 oz.			
2.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	74 (80)	570 (51)	1,426 (62)
	Parathion		1 oz.		1 oz.			
3.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	5 (99)	127 (89)	115 (97)
	Parathion		2 oz.	2 oz.	2 oz.			
4.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	36 (91)	437 (62)	394 (89)
	Parathion		2 oz.		2 oz.			
5.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	1 (99)	20 (98)	86 (98)
	Parathion		4 oz.	4 oz.	4 oz.			
6.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	36 (90)	55 (95)	348 (91)
	Parathion		4 oz.		4 oz.			
7.	Parathion	2 oz.	2 oz.	2 oz.	2 oz.	18 (95)	92 (92)	73 (98)
8.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	175 (54)	58 (95)	345 (91)
	"lorol" 2-thiazolinyl sulfide[3]		3/8 pt.	3/8 pt.	3/8 pt.			
9.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	3 (99)	13 (99)	116 (97)
	"lorol" 2-thiazolinyl sulfide		3/4 pt.	1 1/2 pts.	3/4 pt.			
10.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	588(+55)	40 (97)	172 (95)
	di(p-chlorophenoxy) methane[4]		1/2 lb.	1/2 lb.	1/2 lb.			
11.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	398 (+5)	23 (98)	33 (99)
	di(p-chlorophenoxy) methane		1 lb.	1 lb.	1 lb.			
12.	DDT	8 oz.	8 oz.	8 oz.	8 oz.	3 (99)	23 (98)	2 (99)
	di(p-chlorophenyl)methyl carbinol[5]		4 oz.	4 oz.	4 oz.			

Table 8. Continued

Toxicant	Composition and schedule of applications (Actual toxicant per 100 gallons) 1st May 7	2nd June 4	3rd July 1	4th August 5	Mites/100 leaves (% reduction over treatment 14) - Aug. 4 Clover mite	European red mite	Two-spotted mite
13. DDT di(p-chlorophenyl) methyl carbinol	8 oz.	8 oz. 3 oz.	8 oz. 8 oz.	8 oz. 8 oz.	1 (99)	3 (99)	3 (99)
14. DDT	8 oz.	8 oz.	8 oz.	8 oz.	378	1,160	3,715
15. DDT di(x chlorophenyl) ethane 6/	8 oz.	8 oz. 1 pt.	8 oz. 1 pt.	8 oz. 1 pt.	112 (70)	677 (42)	231 (94)
16. DDT di(x chlorophenyl) ethane	8 oz.	8 oz. 1 qt.	8 oz. 1 qt.	8 oz. 1 qt.	131 (65)	514 (56)	141 (96)
17. DDT DCH salt of DNOCHP 7/	8 oz.	8 oz. 2.4 oz.	8 oz. 2.4 oz.	8 oz. 2.4 oz.	0(100)	1387(+20)	576 (85)
18. DDT Chlorinated camphene 8/	8 oz.	8 oz. 8 oz.	8 oz. 8 oz.	8 oz. 8 oz.	140 (63)	660 (43)	1,342 (64)

1/ From Dampo "50", a wettable powder containing 50 per cent DDT supplied by the Stauffer Chemical Company.

2/ From Thiophos 3422, a wettable powder containing 25 per cent parathion supplied by the American Cyanamid Company.

3/ From IN-4200, an emulsifiable preparation containing 75 per cent "lorol" 2-thiazolinyl sulfide supplied by the E. I. du Pont de Nemours Company.

4/ From Neotran, a wettable powder containing 40 per cent di(p-chlorophenoxy) methane (K-1875) supplied by the Dow Chemical Company.

5/ From Dimite, an emulsifiable preparation containing 25 per cent di(p-chlorophenyl)methyl carbinol supplied by the Sherwin-Williams Company.

6/ From S-1022, an emulsifiable preparation containing 98 per cent di(x chlorophenyl) ethane (K-3926) and 2 per cent emulsifier supplied by the Dow Chemical Company.

7/ From DN-111, a wettable powder containing 20 per cent DCH salt of DNOCHP supplied by the Dow Chemical Company.

8/ From Toxaphene, a wettable powder containing 25 per cent chlorinated camphene supplied by the Hercules Powder Company.

Table 9. Clover mite, Rome Beauty apples, Oak Glen, 1948.

A comparison among acaricides.[1]

	Toxicant	Composition and schedule of applications as actual toxicant per 100 gallons				No. mites[2] per leaf	DDT[3] harvest residues p.p.m.
		June 8	July 9	July 30	August 23		
1.	DDT[4]	8 oz.	8 oz.	8 oz.	8 oz.	8	.3
2.	DDT DCH salt of DNOCHP[5]	8 oz.	8 oz. 2.4 oz.	8 oz. 2.4 oz.	8 oz.	0	---
3.	DDT di(p-chlorophenoxy) methane[6]	8 oz.	8 oz. 8 oz.	8 oz. 8 oz.	8 oz.	10	---
4.	DDT "lorol" 2-thiazolinyl sulfide[7]	8 oz.	8 oz. 3/8 pt.	8 oz. 3/8 pt.	8 oz.	8	.5
5.	DDT di(p-chlorophenyl) methyl carbinol[8]	8 oz.	8 oz. 4 oz.	8 oz. 4 oz.	8 oz.	0	1.7

1/ Applied to eight single tree plots replicated in eight blocks.

2/ From a sample of fifty leaves taken on August 22.

3/ Figures represent an average of three analyses.

4/ From Dampo "50", a wettable powder containing 50 per cent DDT supplied by the Stauffer Chemical Company.

5/ From DN-111, supplied by the Dow Chemical Company.

6/ From Neotran, a wettable powder containing 40 per cent di(p-chlorophenoxy) methane (K-1875) supplied by the Dow Chemical Company.

7/ From IN-4200, an emulsifiable preparation containing 75 per cent "lorol" 2-thiazolinyl sulfide supplied by the E. I.du Pont de Nemours and Company.

8/ From Dimite, an emulsifiable preparation containing 25 per cent di(p-chlorophenyl) methyl carbinol supplied by the Sherwin-Williams Company.

Table 10. Pacific mite, Bartlett pears, Antelope Valley, 1948.

A comparison of acaricides

	Toxicant[1]	Toxicant per 100 gallons	Mite injury[2] average rating
1.	DCH salt of DNOCHP[3]	2.4 oz.	10
2.	bis (p-chlorophenoxy)[4] methane	8 oz.	7
3.	Parathion[5]	2 oz.	12
4.	Tetraethyl pyrophosphate[6]	1/10 pt.	15

1/ Applied as third cover spray on July 18 in addition to one pound of a 50 per cent DDT wettable powder, and on August 10 as a special acaricide spray.

2/ Injury ratings made independently by two observers as follows: 0, none to light; 10, light medium; 20, medium; 30, heavy medium; 40, severe; 50, very severe.

3/ From DN-111 supplied by the Dow Chemical Company.

4/ From Neotran, a micronized wettable powder containing 40 per cent bis (p-chlorophenoxy) methane (K-1875) supplied by the Dow Chemical Company.

5/ From Thiophos 3422, a wettable powder containing 25 per cent parathion supplied by the American Cyanamid Company. Residue data presented in table 12, No. 5.

6/ From Pyrophos 90, contains 20 per cent tetraethyl pyrophosphate and 30 per cent other related organic phosphates supplied by the Stauffer Chemical Company.

Table 11. Apples. A summation of parathion residue studies, 1948.[1/]

Schedule No. and variety	Actual[2/] per 100 gallons	Dates of application	p.p.m., surface, last application: Before	p.p.m., surface, last application: After	Interval in days	p.p.m. after interval: Surface	p.p.m. after interval: Pulp
Conventional sprayer, single gun							
1. Rome Beauty	1 oz.	6/7, 7/8, 7/29	.02	.3	25	.01	
	1 oz.	6/7, 7/8, 7/29, 8/23	.01	.3	41	.02*	0*
2. Rome Beauty	2 oz.	6/7, 7/8, 7/29	.04	.4	25	.02	
	2 oz.	6/7, 7/8, 7/29, 8/23	.02	.4	41	.02*	0*
3. Rome Beauty	4 oz.	6/7, 7/8, 7/29	.09	1.3	25	.09	
	4 oz.	6/7, 7/8, 7/29, 8/23	.09	1.0	41	.05*	0*
4. Rome Beauty	2 oz.	7/29	pulp 0	---	.5	25-45	.03-trace*
5. Rome Beauty	4 oz.	7/29		---	1.2	25-45	.05-trace*
6. Delicious	1 oz.	6/4, 7/1	.01	.5	25-11	.03-.01	
	1 oz.	6/4, 7/1, 8/5	.01	.3	29	.01*	
7. Delicious	2 oz.	6/4, 7/1,	.02	.8	25-11	.04-.01	
	2 oz.	6/4, 7/1, 8/5	.01	.6	29	.01*	
8. Delicious	2 oz.	5/7, 6/4, 7/1	.03	1.4	25-11	.05-.02	0*
	2 oz.	5/7, 6/4, 7/1, 8/5	.02	.6	29	.02* cider	0 0[3/]
9. Delicious	4 oz.	6/4, 7/1	.09	2.2	25-11	.1 -.05	
	4 oz.	6/4, 7/1, 8/5	.05	.9	29	.05* cider	0* 0
Speed sprayer							
10. Delicious	2 oz. (400 gal/acre)	7/22		---	.3	22	.01
11. Delicious	4 oz. (200 gal/acre)	7/22		---	.4	22	.01
12. Delicious	4 oz. (200 gal/acre)	7/22		---	.5	22	.04
13. Delicious	8 oz. (100 gal/acre)	7/22		---	.2	22	.01

1/ All residue figures represent an average of three analyses.

2/ From a wettable powder containing 25 percent parathion supplied by the American Cyanamid Company.

3/ Values reported for cider are from analyses of expressed juice from entire fruits of the same series bearing the indicated surface residues at harvest.

* Harvest

Table 12. Bartlett pears. A summation of parathion residue studies, 1948.[1/]

Schedule No.	Actual[2/] 100 gals.	Dates of application	p.p.m. surface, last application Before	p.p.m. surface, last application After	Interval Days	Mean temp. °F.	p.p.m. after interval Surface	p.p.m. after interval Pulp
Conventional sprayer, single gun.								
1.	2 oz.	7/14, 8/11	.01	.3	7	76°	.08*	
2.	2 oz.	5/5,6/10,7/7	.01	.5	21	79°	.03*	
	2 oz.	5/5,6/10,7/7, 7/28	.03	.7	33	78°	.01	
3.	4 oz.	5/5,6/10,7/7	.02	.8	21	79°	.04	
	4 oz.	5/5,6/10,7/7 7/28	.04	1.1	33	78°	.02*	0*
4.	8 oz.	5/5,6/10,7/7	.03	2.6	21	79°	.08	
	8 oz.	5/5,6/10,7/7 7/28	.08	2.1	33	78°	.04*	0*
Conventional sprayer, broom guns.								
5.	2 oz.	7/18,8/10	.005	.3	7	76°	.06*	
Conventional sprayer, fixed nozzle vertical boom.								
6.	2 oz.	4/28,5/26,6/28 7/20	.01	.2	17-11	81°-76°	.03-.02*	0-0*
Citrus spray-duster								
7.	8 oz. (200 gal/acre)	7/8	---	.2	27	81°	.03	
		7/8,8/4	.03	.3	22	75°	.005*	
Speed sprayer								
8.	1 oz.	7/13	---	.1	25	81°	0	0
9.	2 oz.	7/13	---	.2	25	81°	.001	0
10.	4 oz.	7/13	---	.3	25	81°	.004	0

1/ All residue figures are an average of three analyses.

2/ A wettable powder containing 25 per cent parathion supplied by the American Cyanamid Company, was used in all sprays.

* Harvest

Table 13. Bartlett pears and Rome Beauty apples, parathion residue removal studies.[1]

No.	Material	Per 100 gallons	Approximate pH	Parathion surface residues in p.p.m. and per cent removed[2]					
				Series #1[3] Bartlett pears		Series #2[4] Bartlett pears		Series #3[5] Green Rome Beauty apples	
				p.p.m.	%	p.p.m.	%	p.p.m.	%
1.	No treatment (unwashed)			.27		.07		.32	
2.	Trisodium phosphate[6]	8 lbs.	Greater than 10	.23	-15	.03	-57	.30	- 6
3.	Trisodium phosphate Santomerse No. 1[7]	8 lbs. 2 oz.[9]	Greater than 10	.25	- 7	.04	-43	.28	-12
4.	Trisodium phosphate	16 lbs.	Greater than 10	.17	-37	.04	-43	.30	- 6
5.	Trisodium phosphate Santomerse No. 1	16 lbs. 2 oz.	Greater than 10	.21	-22	.03	-57	.33	---
6.	Sodium tri-phosphate[6]	8 lbs.	9	.23	-15	.03	-57	.30	- 6
7.	Sodium acid pyro-phosphate[6]	8 lbs.	4	.20	-26	.03	-57	---	---
8.	Sodium acid pyro-phosphate Tetra sodium pyro-phosphate[6]	4 lbs. 4 lbs.	7	.21	-22	.03	-57	.28	-12
9.	Tetra sodium pyrophosphate	4 lbs.	9	.25	- 7	.04	-43	.25	-22
10.	Tetra sodium pyro-phosphate Santomerse No. 1	4 lbs. 2 oz.	9	.18	-33	.04	-43	.30	- 6
11.	Trisodium phos-phate Triton X-100[10]	8 lbs. 36 cc.	Greater than 10	.23	-15	.03	-57	.22	-31
12.	Tetra sodium pyrophosphate	8 lbs.	10	.22	-19	.04	-43	.24	-25

Table 13. Continued

No.	Material	Per 100 gallons	Approximate pH	Parathion surface residues in p.p.m.[2] and per cent removed					
				Series #1[3] Bartlett pears		Series #2[4] Bartlett pears		Series #3[5] Green Rome Beauty apples	
				p.p.m.	%	p.p.m.	%	p.p.m.	%
13.	Tetra sodium pyrophosphate Santomerse No. 1	8 lbs. 2 oz.	10	.28	---	.05	-29	.27	-16
14.	Sodium silicate[8]	80 lbs.	Greater than 10	.20	-26	.03	-57	.21	-34

1/ Temperature of wash water 20° C., wash 35 seconds, rinse 25 seconds, Ideal Fruit Washer, Model W.K.A.

2/ An average of two analyses was made for each treatment.

3/ Fruits of this series specially sprayed with 4 ounces actual parathion per 100 gallons.

4/ Fruits of this series sprayed with 2 ounces of actual parathion per 100 gallons on July 18 and August 10, sampled August 26.

5/ Fruits of this series were sampled after fourth cover of 4 ounces of actual parathion per 100 gallons.

6/ Supplied by the A. R. Maas Chemical Company.

7/ Supplied by the Monsanto Chemical Company.

8/ B. W. Brand, sodium silicate, Philadelphia Quartz Company.

9/ Maximum amount without excessive foaming.

10/ Supplied by the Rohm and Haas Company.

Table 14. Rome Beauty apples, parathion residue removal studies.[1/]

No.	Material	Per 100 gallons	Approximate pH	Parathion surface residues in p.p.m.[2/] and per cent removed	
				p.p.m.	%
1.	No treatment (unwashed)			1.09	
2.	Trisodium phosphate	8 lbs.	Greater than 10	.82	- 25
3.	Tetrasodium pyrophosphate	3 lbs.[3/]	9	1.12	----
4.	Tetrasodium pyrophosphate (through washer twice)	3 lbs.	9	1.03	- 6
5.	Sodium acid pyrophosphate	8 lbs.	4	1.02	- 6
6.	Sodium acid pyrophosphate Santomerse No. 1	8 lbs. 2 oz.	4	.77	- 29
7.	Sodium acid pyrophosphate Santomerse No. 1 (through washer twice)	8 lbs. 2 oz.	4	.99	- 9

1/ Temperature of wash water 11° C., wash 35 seconds, rinse 20 seconds, B.A.D.D. washer, Bean Cutler Division, Food Machinery Corporation.

2/ Each figure represents an average of three analyses.

3/ Impractical at the time to dissolve more in water at 11° C.

COLORADO

J. H. Newton, Colorado Agricultural Experiment Station, Paonia.

Codling Moth and Mite Control in Colorado

Codling moth and mite control in Colorado consisted of two projects as in 1947. (1) Control on pears in Mesa County and (2) Control on apples in Delta County.

Control on pears (M. L. Dilley Orchard) Clifton, Colorado

Eight spray treatments replicated four times on plots of six trees each. All harvest and drop fruits were counted and scored from two trees of each plot. No calyx applications were made.

A dormant application of lime sulfur to the entire experimental orchard reduced the brown or clover mite (Bryobia pratensis) to the point that it never appeared as a problem during the season. This also controlled a moderate infestation of pear leaf blister mite (Eriopheyes pyri Pgst.) and Howard or Putnam scale.

A two spotted spider mite (Tetranychus spp.) has usually been a problem on pears in this orchard late in the season. It breeds up on wild morning glory or bindweed from which it migrates to the pear trees in August and September. In the experimental plots effective control was obtained by spraying the under growth with parathion or DN-111 as miticides. Bindweed so sprayed came into full bloom whereas those plants unsprayed in other portions of the orchard failed to bloom and in many instances turned brown and dried up. Following this drying up of their host plants the mites migrated to the nearest pear trees in large numbers.

Codling moth control: Table 1, lists the treatments and materials used, together with the Means and Adjusted Means of the Seasons fruit, Wormy fruit and Adjusted ranks. Also the Mean wormy fruit per 1000 pears for each treatment. The following conclusions are self evident:

1. Three and four applications of DDT equally effective. This is in agreement with the results of 1947.

2. Two cover applications of DDT significantly inferior to three or four at the 5 percent level.

3. Parathion (25%) 2 1/2 oz.-100 combined with DDT did not reduce or improve the control.

4. Four and three applications of DDT highly superior to four applications parathion at 1 lb.-100 dosage.

5. Four and three applications of DDT superior to four applications. Parathion at 2 lbs.-100 dosage but not significantly so.

6. Two cover applications of Lead arsenate-kerosene-soap mixture for the first brood followed by two cover applications Black Leaf 155 with summer oil for the second brood was the most ineffective treatment tested.

7. Methoxychlor (Methoxy DDT) was not as effective as DDT.

Control on apples (Thomas J. Bird Orchard) Paonia.

The experiment consisted of twelve treatments replicated 6 times on single tree randomized plots. All tests were made in a Jonathon orchard of well pruned trees of reasonably uniform size and vigor. The size and spacing of the trees was such that the drift was not a problem. All sprays were applied with a conventional power sprayer using 600 to 700 pounds pressure, the trees being sprayed from the inside out and the outside in.

No dormant or delayed dormant sprays had been applied. Mildew which is often serious on this variety did not develop. Common red spider which was very serious in some orchards of the vicinity was not numerous enough to warrant taking records. The season started with a moderate to heavy infestation of clover mites. Mite injury was quite severe under those treatments which gave poorest control. (See Table 2 for record of brown or clover mite eggs in the calyx cups at harvest)

Due to a heavy set of fruit and no thinning the size of the fruit was below normal for the variety. Table No. 2 presents the number and wormyness of all windfall and harvest fruit. The June drop which was very light is included. It is felt that the number of worms that enter with a treatment is a more valuable measure of effectiveness than the percentage of wormy fruit alone. With less efficient treatments, two, three, or even five or more larvae may enter a single fruit. An analysis of covarience was made of the data. Such a study permits adjusting the record for all treatments to a uniform crop basis thus elmininating a very important variable. Systematic examinations of the foliage and fruit of each plot were made to determine the phytotoxic effects of the various spray combinations.

Woolly apple aphid did not develope in any of the plots except on an occasional twig or small limb. Woolly apple aphids were unusually scarce in most orchards of the North Fork Valley whether sprayed with DDT or not.

Rosy apple aphids continue to be very scarce in those orchards which were sprayed with DDT for codling moth control the previous season.

Codling moth control: (Summary for apples)

1. DDT was the most effective material for codling moth control.

2. Superiority of 4 applications of DDT over 3 applications highly significant.

3. Superiority of 5 applications of DDT over 4 applications indicated but not found significant.

4. Two applications DDT failed so completely the program was abandoned.

5. DDT equally effective combined with DN-111, Selocide, Sulfur or Parathion.

6. Neotran significantly reduced effectiveness of DDT.

7. Four applications DDT significantly more effective than four applications of Parathion (25%) at 1 lb. or 2 lbs.-100 gals.

8. Two applications of lead arsenate on the first brood in combination with kerosene-soap, followed by two applications of Black Leaf-155 with summer oil for second brood control allowed 4 times as many worms to enter as 4 applications of DDT.

9. Two and one-half ounces of Parathion (25%) combined with DDT did not increase codling moth control or give any significant control of the clover mite.

10. DN-111, 3/4 lb., Selocide 1 qt., Parathion 1 and 2 lbs., and wettable sulfur 6 lbs. to 100 gallons, all gave effective and equal control of the clover mite.

11. The lead arsenate-Black Leaf 155-summer oil treatment gave significant but unsatisfactory control of the clover mite.

12. IN-4200 - 1 pt. - 100 gals. in 3 applications gave little clover mite control. Severe spray injury resulted to fruit and foliage.

13. Neotran-1 lb.-100 gals. in three applications gave little clover mite control. Apples show slightly discolored blotches and are shriveling in storage.

Suggested 1949 spray program for the control of codling moth, clover mite, two spotted mite and mildew: DDT 1 1/2 lbs., sulfur 6 lbs.-100 gals. four applications; in problem orchards 5 applications.

Storage and fruit quality: Storage and fruit quality tests of the fruit from the different treatments of both pears and apples are being conducted as a cooperative project with the Chemistry Section of the Colorado Experiment Station. These studies will be reported at a later date.

Table 1. Results of tests to control codling moth on Bartlett pears. Clifton, Colo. Season of 1948. M. L. Dilley orchard.

Materials and quantities per 100 gallons	No. applications	Mean seasons fruit per treatment	Original rank	Mean wormy fruit per treatment	Adjusted mean wormy fruit per treatment	Adjusted rank	Mean wormy fruit per 1000 pears	Residue in ppm
(1) [1] DDT 1 1/2 lbs. DN-111 3/4 lbs.[2]	4	1991.0	3	14.25	-9.70	1	-5.3	4.0 DDT
(2) DDT 1 1/2 lbs. DN-111 3/4 lb.	3	1876.5	4	18.50	1.43	2	0.70	3.2 DDT
(3) DDT 1 1/2 lbs. DN-111 3/4 lb.	2	1722.2	7	64.5	56.71	6	32.9	3.0 DDT
(4) Methoxy[3] DDT 3 lbs. IN-4200[4] 1 pt.	4	1482.0	2	9.0	15.66	4	10.6	5.7
(5) DDT 1 1/2 lbs. Parathion(25%) 2 1/2 oz.	4	1483.25	1	5.00	11.59	3	7.8	0.025 Parathion
(6) Parathion (25%) 1 lb.	4	1084.25	5	31.5	62.09	7	57.3	0.035 Parathion
(7) Lead arsenate 3 lbs.-kerosene-soap mix: B.L.-155 3 lbs., summer oil 1 qt. 3rd.-4th.spray	4	1536.0	8	121.5	124.92	8	81.6	3.00 lead
(8) Parathion (25%) 2 lbs.	4	1567.25	6	46.75	48.28	5	30.8	0.077 Parathion
Difference required for significance:			5% point		61.6			
			1% point		84.1			

1. 1,1,1-trichloro-2,2 bis (p-chlorophenyl) ethane
2. Triethanolamine salt of dinitro-ocyclohexlphenol
3. 2,2 bis (p-methoxyphenyl) 1,1,1-trichloroethane
4. Alkyl-2 thiazolinyl sulfides

Spray dates: May 14th., May 29th., July 1st., and 14th. Samples taken for residue analysis August 14th.

Table 2. Results of tests to control codling moth and clover mite on Jonathon apples. Thomas J. Bird orchard, Paonia, Colo.

Materials and quantities per 100 gallons	No. applications	Mean harvest and windfall	Mean worms per treatment	Adjusted mean worms per treatment	Worms per 1000 apples	Treatment rank	Mean clover mite eggs per sample	Residue in ppm
(3) DDT-1 1/2 lbs. DN-111 - 3/4 lb.	5	5011	366.3	281.0	64	1	3.6	4.0 DDT
(10) DDT 1 1/2 lbs. 8-6 lbs. Sulfur	4	4691	440.3	400.8	91	2	0.4	2.2 DDT
(9) DDT-1 1/2 lbs. Selocide 1 qt. B-1956 spreader 1 oz.	4	5280	597.7	474.1	107	3	0.6	2.3 DDT
(5) DDT-1 1/2 lbs. Parathion 2 1/2 oz.	4	3947	411.3	477.9	108	4	158.4	3.2 DDT 0.003 Parathion
(1) DDT-1 1/2 lbs. DN-111 - 3/4 lb.	4	5469	761.0	610.3	138	5	2.2	3.6 DDT
(8) Parathion 2 lbs.	4	3500	761.5	891.9	202	6	0.6	0.08 Parathion
(6) Parathion 1 lb.	4	3738	843.0	939.4	213	7	5.0	0.04 Parathion
(4) Methoxychlor 3 lbs.;IN-4200 1 pt.	4	4103	968.2	1012.6	229	8	423.8	5.5 DDT
(11) DDT 1 1/2 lbs. Neotran 1 lb.	4	4826	1132.2	1073.4	243	9	349.4	3.5 DDT
(2) DDT 1 1/2 lbs. DN-111 3/4 lb.	3	3417	980.5	1122.8	254	10	12.0	2.6 DDT
(0) DDT 1 1/2 lbs. DN-111 3/4 lb.	3	5211	1328.0	1214.1	275	11	10.8	1.8 DDT
(7) Lead arsenate 3 lbs.-kerosene-soap mix-1st. Br. B.L.155 3 lbs.s-oil 1 qt. for 2nd. Brood	4	3770	1537.8	1629.7	369	12	77.0	3.0 Lead
Difference required for significance 5 percent point				602.8			106.2	
1 percent point				803.0			141.9	

Spray dates: May 25, June 9, July 10, July 27, Aug. 11. Residue samples taken Sept. 30th.

Key to Table 2: DDT-1,1,-trichloro-2,2 bis (p-chlorophenyl) ethane; DN-111-Triethanolamine salt of dinitro-o-cyclohexylphenol: Selocide-Potassium-ammonium-seleno-sulfide: Parathion-o,o-diethyl o-p-nitrophenyl thiophosphate: Methoxychlor-2,2-bis (p-methoxyphenyl) 1,1,1 trichloroethane: IN-4200-Alkyl-2-thiazolinyl sulfides: Neotran-Bis (p-chlorophenoxy) ethane.

DDT was reduced to 1 pound in fifth application of the spray treatment (No. 3); Sulfur was reduced from 8 to 6 pounds in last two applications: Parathion 25 percent concentration; IN-4200 used in first and third applications only: Neotran used in first and third applications.

DELAWARE

L. A. Stearns, Delaware Agricultural Experiment Station, Newark.

Seasonal Conditions and Codling Moth Abundance

Observations on the transformation of overwintered larvae in each of the three Delaware counties showed 5 percent pupated on April 2; 64 percent, on April 23; and 91 percent, on May 10. Emergence of the spring brood of moths commenced May 1 and ended June 21; 97 percent of emergence occurred in May and but 3 percent, in June. The first moths of this brood were captured in bait traps on May 10. Emergence of the first brood of moths commenced July 13 and ended August 14; 98 percent of emergence occurred in July and but 2 percent, in August.

The data on which these statements are based were collected for the purpose of accurate timing of spray-service recommendations. The apple program included both lead arsenate and DDT in several covers. Generally, codling moth injury was negligible; mite infestation varied from light to heavy, depending on growers' efforts to check it; and damage by red-banded leaf roller, at its worst, was recorded as moderate.

No experimental spraying for codling moth control was done in 1948. Research on fruit was limited to extensive testing of new insecticides against the plum curculio on peach.

GEORGIA

R. A. Irvin, Fruit Pest and Parasite Laboratory, Cornelia.

1. Seasonal Conditions and Status of Codling Moth Infestations During 1948

The weather was moderate, but very rainy throughout March, with a killing frost occurring on March 29th which killed almost all of the buds

and blooms on the trees located in low places. Trees on high places were damaged only slightly.

Bait traps were put out at two locations on April 15th and the first adult codling moth was found on April 19th.

The largest number of moths was taken in April at both locations. The number of moths showed a steady decrease, in August only one moth was caught and none in September. Total number of moths caught in ten bait traps was 521.

2. Codling Moth Control Experiments:

Eight sprays were applied to twenty trees. Spray used was "Fermate," a Du Pont fungicide and DDT, 50 percent wettable. Five trees were used for checks and were sprayed according to the regular schedule. All trees were sprayed at about two week intervals starting on the 26th of March.

3. Results:

Fruit from two trees out of each plot was scored. Total was 10 trees checked.

Total Fruit	Clean Fruit	Wormy Fruit	Stung Fruit	Percent Free of Worms
18,217	15,460	603	310	96.7

4. Distribution of Trichogramma minumtum

A total of 15,352,000 T. minumtum parasites were mailed to apple growers in 21 counties of Georgia.

ILLINOIS

S. C. Chandler, State Natural History Survey Division, Carbondale.

Orchard Tests with DDT for the Control of Codling Moth in Illinois, 1948

During the three seasons previous to 1948, a study of the value of a DDT schedule as compared with our standard lead arsenate-nicotine spray program for apples was conducted. These large scale experiments using unreplicated blocks in eight to twelve orchards located over a large area in central and southern Illinois showed an average of approximately three times as many picked wormy apples at harvest for the three year period in blocks receiving our best standard schedules as in those in which DDT had been substituted in part for lead arsenate and fixed nicotine.

In 1948 the number of test orchards was reduced to three, one in central and two in southern Illinois. In all three the comparison was changed, so that beginning with the fifth or sixth covers, when larval entrances or attempted entrances were first observed in any appreciable numbers, DDT was introduced into the standard schedule. Up to this time the growers themselves could not detect any differences between blocks. There is a general desire among growers to hold off the use of DDT as long as possible to eliminate some of the hazards of its use on apples. Final infestation data based on examinations of 1,000 apples at harvest, 300 in tops and 700 in the lower parts, are shown in the accompanying table:

Orchard No.	DDT Throughout Percent of Apples		Standard Early, DDT Later Percent of Apples	
	Wormy	Stung	Wormy	Stung
1	0.0	.6	.6	2.2
2	3.7	24.3	4.7	53.0
3	9.9	17.9	19.9	21.7
Average	4.5	14.3	8.4	25.6

This shows approximately twice as many wormy and stung apples in the "delayed DDT" blocks as in those receiving DDT throughout the season.

During the past three years' tests DDT-sprayed blocks have shown poorer foliage and frequently poorer finish on the fruit than those receiving the standard lead arsenate-DDT schedules, due to mite and oil-DDT injury. In this year's tests there was less difference in appearance indicating that omission of DDT from the early sprays did not eliminate the evils of DDT in proportion to the number of applications in which it was used.

INDIANA

G. Edward Marshall, Indiana Agricultural Experiment Station, Orleans.

Seasonal Conditions

The 1948 season was a rather moderate one in central Indiana as far as the temperature is concerned. The rainfall amounted to 5.68 inches between April 12 and May 1. It was 2.91 inches for May, 2.88 inches for June, [illegible] for July, 2.94 for August, and 3.83 for September. Apple scab was rather difficult to control, cedar apple rust was less prevalent than in the past

several years, bitter rot failed to become a factor in production, the leaf roller did not cause trouble, aphids did not become a problem, and spider mites built up to populations which barely missed presenting a problem of control, however, no infestation in the commercial orchards of this vicinity warranted a spray for control this year.

Objective

To study the control of the heaviest codling moth infestations procurable giving particular attention to the minimum number of DDT sprays necessary to secure commercial control through the use of the conventional type of spray equipment (such as is used in Central Indiana). Consistently heavy infestations usually involve inflight of moths from without the orchard proper. In most instances the usual type of DDT spray program, if it is effective against the codling moth involves spider mites. To prevent populations of mites of sufficient magnitude to necessitate the application of one or more miticidal sprays, was also a primary purpose of the study. An evaluation of the effectiveness of well-timed orchard border or spot sprays at points of heavy inflight was given special attention.

The Experimental Orchard

This orchard contains slightly less than 20 acres of mixed young and old apple trees. It carried only a moderately heavy infestation of the codling moth through the winter of 1947 to 1948. The harvest infestation in 1947 was about 15 percent wormy fruit. Approximately 700 used baskets were brought in from another orchard during the late fall of 1947, and many of these carried 25 to 30 overwintering larvae. The baskets were placed in a shed which later permitted unopposed emergence and flight back to the orchard. After scab sprays were completed a two DDT schedule was applied to the entire orchard as shown in Table 1. In addition spot and orchard border spraying was done as seemed necessary. To determine when and where extra sprays were needed careful watch was kept to learn at what time eggs from migrant moths were beginning to hatch, and in what part of the orchard most of this was taking place. Two extra sprays, and these of DDT, were applied accordingly. The shed in which the baskets were put is at the northwest corner of the planting on the highest ridge in the orchard. The heaviest attack occurred on the three rows of trees along the west side of the orchard, and east from the shed eight rows out along the ridge.

Table 1 of the spray schedule will reveal that one of these spot sprays was applied eight days before the entire orchard was sprayed with DDT the first time. The other spot spray was put on about eight days before the entire orchard was sprayed the second and last time with DDT.

Table 1 1948 APPLE SPRAY PROGRAM EXPERIMENTAL ORCHARD

Date	Spray	Material Used	Type of Application
April 26	Calyx	3# lead arsenate, 3# lime, 6# wettable sulphur	from tower around trees
May 3-4*	7 day (1st. cover)	2 2/3# dry lime sulphur & 5# wettable sulphur - no insecticide put in this application	all around
May 14	14 day spray (2nd. cover)	3# lead arsenate, 3# lime, 2 2/3# dry lime sulphur, 4# wettable sulphur	all around trees from tower
May 17-18	14 day spray (2nd. cover under)	3# lead arsenate, 3# lime, 2 2/3# dry lime sulphur, 4# wet. sulphur	under trees
June 1**	1st. DDT (around packing house, out the ridge & down the west border)	2# 50 percent wettable DDT	under and outside on big trees - outside only on young stuff
June 8,9, & 10***	1st. DDT (entire orchard)	1 pt. Black Leaf 40, 5# Wyoming bentonite, 1 qt. soy bean oil, 2# 50 percent wettable DDT	outside from ground outside from tower under
June 30-July 1****	3rd. DDT (around packing house, out ridge, down west border)	1# 50 percent DDT	around from ground and from tower
July 8 July 14-15, and 16	2nd. DDT (entire orchard)	1 pt. Black Leaf 40, 5# Wyoming bentonite, 1 qt. soy bean oil, 1.16# actual DDT	from tower July 8 from under & ground on outside July 14-15 and 16.

* Rather serious foliage injury from high winds.
** Emergence of moths from packing house unopposed this year.
*** Worms had a good start in this orchard. We are possibly past the peak of hatch and definitely past peak of moth flight.
**** Between broods but heavy packing house emergence continuing. July 24 emergence of codling moth adults completed in packing house and from cool locations.

At harvest time two apples from each bushel were taken to determine the infestation. From examinations of these it was determined that the harvest infestation amounted to 6.83 worms and 25.5 stings per 100 apples. The number of stings would have been materially reduced if the first DDT application to the entire orchard had not been delayed until hatch was well under way. However, if control is to be accomplished using such a program, the time of the first application with respect to egg hatch and first brood moth flight, must be decided upon rather precisely. This schedule applied, and the results indicate that it is possible to control the codling moth with two well-applied DDT sprays if the infestation is confined to the orchard proper, but that more sprays will be necessary if there is considerable inflight.

The population of spider mites did not develop to any considerable magnitude in the two DDT spray section of the orchard though a much heavier infestation developed on Turley in the four DDT spray area.

The Thomas Orchard

This orchard is in the suburbs of Mitchell, and around it are scattered many apple trees the owners of which give them just enough care to produce a crop of wormy apples. Thus there is always a considerable inflight of moths from the outside into this test planting. The 1947 crop was light and very wormy. The orchard is 32 trees long from north to south, and 15 rows wide with a four acre planting of Stayman Winesap cornering up on the northeast. Only the Stayman block of trees were used in 1948 so that all the overwintering larvae in the 15 by 32 tree block emerged and flew where they would. In addition all the moths produced in the 15 by 32 tree block during the summer migrated freely inasmuch as no codling moth sprays were applied to the light crop of fruit which set in this area. Apple scab was well controlled, and the fruit hung on until the crop was taken by the codling moth.

Two rods west of the border and at the middle of the four acre block of Stayman stands the packing house, and 10 rods west of that is the storage (without refrigeration). From both these structures thousands of moths emerged during the season and flew back to the orchard. The last emergence from the overwintering brood in the storage was noted on July 24.

Table 2 gives the spray schedule of insecticides applied to this four acre block of Stayman after apple scab had been well controlled. A division of this small orchard into plots was for the purpose of studying the residue retention by the use of Armour's sticker rather than codling moth control. The block carried a rather uniformly light crop of fruit, but it was divided in half for convenience of spraying. The sticker plot (A) consisted of the west half nearest the packing house and storage. For this reason the two plots are not comparable with respect to control by the two spray combinations because in plot A the codling moth attack was much greater as the result of the inflight from the west. Be that as it may the average infestation of this light crop in both plots was about 16 worms and 90 stings per 100 apples.

Table 2 — 1948 APPLE SPRAY PROGRAM - THOMAS ORCHARD

All sprays preceeding the first DDT application very similar to those put on at the Exp. Orchard			
Date	Spray	Material Used	Type of Application
April 27	calyx	1 gal. liquid lime sulphur, 4# wettable sulphur, 3# lead arsenate	all around trees from tower and ground
May 10	1st. cover	1 gal. lime sulphur, 4# wettable sulphur, 3# lead arsenate, 3# lime	all around trees from tower and ground
June 11-12*	1st. DDT	(Plot A-12 oz. actual DDT, 1½# Armour's sticker (Plot B-12 oz. actual DDT	all around trees from tower and under
June 28, 29, and 30	2nd. DDT	(Plot A-8 oz. actual DDT, 1½# Armour's sticker (Plot B-8 oz. actual DDT	all around trees from tower and ground
July 19	3rd. DDT	(Plot A-12 oz. actual DDT, 1½# Armour's sticker (Plot B-12 oz. actual DDT	all around trees from tower and ground
August 5	4th DDT	(Plot A-12 oz. actual DDT, 1½# Armour's sticker (Plot B-12 oz. actual DDT	all around trees from tower and ground

*Tremendous number of entrances made between one and four days before this application. Moths coming from packing house, storage, and orchard to the south west.

This schedule and the handicaps of light crop, constant inflight of moths, and the fact that the first DDT application was made four days after a peak of hatch offers proof that no matter how severe the infestation, and no matter how far the season has developed (providing there are some apples left unattacked) the codling moth can be stopped in its tracks with no more than four thorough DDT applications. It also indicates that in areas where there is a constant inflight of moths a two DDT spray program cannot be depended upon.

Spider mite (two spot) built up to a population which would warrant counteractive sprays in the part of this orchard given four DDT sprays.

Summary and Conclusions

Through this experiment a number of summarizing statements may be made which statements would seem to be important to the grower looking for an economical, effective codling moth program with a minimum of trouble from mites.

1. With constant inflight into the orchard:

    A. If the orchard is small two DDT containing sprays after scab control season is past will not insure satisfactory control of the codling moth.

    B. If the orchard is fairly large, if sufficient attention is given to points of inflight, and to the time when successful entrances by the larvae are beginning a couple of extra sprays (well-timed and applied to areas around packing houses, storages, along ridges or to three or four border rows of the orchard) in addition to two over-all sprays of DDT, may be expected to give satisfactory control.

2. If the infestation is confined to the orchard:

    A. Two well-applied and well-timed DDT sprays may be all that is necessary.

    B. In some years and under some conditions an application of oil and nicotine or some such spray may be necessary about the first of September or at the time of the third brood hatch of codling moth and before cool weather slows development.

3. At Mitchell in three years of observation two DDT applications put on approximately a month apart have not resulted in a population of spider mites which warranted special attention. Therefore when special spot sprays are needed to control inflight, or when the orchard is small enough that moths flying in will spread over the entire planting making extra sprays necessary, spider mite build-up might be averted if these extra sprays consisted of something other than DDT.

KANSAS

E. L. Eshbaugh, Kansas Agricultural Experiment Station, Manhattan.

Codling Moth Control in Kansas During 1948

Introduction

Studies in northeast Kansas since 1944 have indicated the effectiveness of DDT as a codling moth insecticide. Studies since 1945 showed the possibility of the occurrence of the two-spotted mite and red-banded leafroller in orchards sprayed with DDT. Additional studies of DDT and other materials for codling moth control were made in northeast Kansas in 1948 and observations made on mite and red-banded leafroller damage in experimental plots.

Seasonal Conditions and Codling Moth Abundance

Warm weather during the early spring caused codling moth emergence to start in northeast Kansas by May 5. Most of the first brood emergence was completed by June 7. A large number of eggs hatched between May 16 and May 28. Moths producing the second brood larvae began to emerge on June 25. Frequent rains during July and August caused interruptions of spray schedules and loss of residue resulting in a large number of stung fruits. Moths producing the third brood larvae started to emerge on August 5. The emergence of moths of this brood continued into October.

Codling moth control was good in most orchards receiving the required number of first, second, and third brood sprays. A light apple crop combined with interrupted spray schedules resulted in more wormy and stung fruits than in 1947.

1948 Tests

The combinations of insecticides used in 1948 are indicated in Table 1.

The experimental work for fruit insect control was done in the Blair experiment orchard at Blair, Kansas. Two single tree replicates randomized in 10 rows of trees, each row containing 10 trees, were used for each insecticide or combination of insecticide tested. The variety of apple used was Jonathan. Two early sulfur sprays were applied for apple scab control. Lead arsenate, 4 pounds to 100 gallons of water, was applied uniformly to all trees in all plots in the calyx spray on May 1, except one plot in which the calyx spray was omitted and the check plot which received no insecticide sprays. Four to eight spray applications were made to the trees in all plots except the check plot. The sprays, timed in accordance with two sets of codling moth bait traps were applied as follows: First cover, May 14; second cover, May 21; third cover, May 28; fourth cover, June 8; fifth cover, July 2; sixth cover, July 13; seventh cover, July 28. Because of an unavoidable delay the eighth cover spray was not applied until August 18.

Wormy, stung, and clean dropped apples were recorded for each tree at intervals during the summer to September 11. A light set of fruit made necessary the recording of all harvested fruits from the trees.

Table 1. Insecticides, dosages, and schedules used in control tests in pounds per 100 gallons of spray mixture.

All plots except the check and one plot where the calyx spray was omitted had a calyx spray of 4 pounds of lead arsenate.

1.	Check plot - no insecticide treatment.
2.	Lead arsenate, 4 lb., 8 covers.
3.	Lead arsenate, 4 lb. plus zinc sulfate, 4 oz. plus summer oil emulsion, 2 qts., oil omitted after 5th cover. 8 covers.
4.	Lead arsenate, 4 lb. plus 3/4 lb. "DN Dry Mix No. 1" 1/ in 5th and 7th cover sprays. 8 covers.
5.	DDT, 2/ 1½ lbs. in 1st, 3rd, 5th ,and 7th covers. 4 covers.
6.	DDT, 1½ lb. in 1st, 3rd, 5th and 7th covers plus 2 lb. 40 percent "Neotran" 3/ in 5th and 7th covers. 4 covers.
7.	DDT, 1½ lb. in 1st, 3rd, 5th and 7th covers plus ½ lb. "DN-111" 4/ in 4th, 5th, 6th and 7th covers. 6 covers.
8.	DDT, 1½ lb. in 1st, 3rd, 5th, 7th covers plus 5 oz. "DN Dry Mix No. 1" in 4th, 5th, 6th and 7th covers. 6 covers.
9.	DDT, 1½ lb. in 1st, 3rd, 5th, 7th covers plus 3/4 lb. "DN Dry Mix No.1" in 5th and 7th covers. 4 covers.
10.	DDT, 1½ lb. in 1st, 3rd, 5th, 7th covers plus "Parathion" 5/ ½ lb. in 4th, 5th, 6th and 7th covers. 6 covers.
11.	"Rhothane WP-50", 6/ 3/4 lb. plus "CR-1639", 7/ 1½ pints. 7 covers.
12.	DDT, 1½ lb. in 1st, 3rd, 5th, 7th covers plus "IN-4200", 8/ ½ pint in 4th, 5th, 6th and 7th covers. 6 covers.
13.	BHC (Isotox), 9/2 lb. in 1st and 2nd covers; DDT (Persisto), 10/ 1½ lb. in 3rd, 5th, and 7th covers. 5 covers.
14.	No calyx spray. Lead arsenate, 4 lb. plus zinc sulfate, 4 oz. in 1st and 2nd covers; DDT, 1½ lb. in 3rd, 5th, and 7th covers plus 3/4 lb. "DN Dry Mix No. 1" in 5th and 7th covers. 5 covers.
15.	"Black Leaf 155", 11/3 lb. in 1st and 2nd covers; "B.L 155", 2 lb. plus 2 qts. summer oil in the 3rd through 8th covers. 8 covers.
16.	"Black Leaf 155-DDT", 12/3 lb. in 1st and 2nd covers; "B.L. 155-DDT", 2 lb. plus 2 qts. summer oil, 3rd through 8th covers. 8 covers
17.	"Miticidal DDT", 13/ 5 lb., 7 covers.

1/ A concentrated dinitro compound (Dow Chemical Co.)
2/ Deenate-50-W (E. I Du Pont de Nemours & Co., Inc.)
3/ Bis(p-chlorophenoxy)methane (Dow Chemical Co.)
4/ A derivative of dinitro ortho cyclohexylphenol (Dow Chemical Co.)
5/ Twenty-five percent diethyl p-nitrophenyl thiophosphate(American Cyanamid Co.)
6/ Fifty percent dichloro-diphenyl-dichloroethane (Rohm & Haas Co.)
7/ A dinitro compound (Rohm & Haas Co.)
8/ An emulsifiable "Lorol" -2- thiazolinyl sulfide solution (E. I. Du Pont de Nemours & Co., Inc.)
9/ California Spray Chemical Corp..
10/ California Spray Chemical Corp..
11/ A fixed nicotine (Tobacco By-Products Corp.)
12/ Seven percent of 100 percent soluble nicotine plus 17 percent DDT (Tobacco By-Products Corp.)
13/ DDT plus hydroxy pentamethyl flavan (E. I. Du Pont de Nemours & Co., Inc.)

Results

Data for the various insecticide tests for the control of codling moth in the Blair experiment orchard at Blair, Kansas are recorded in Table 2.

Table 2. Percentages of wormy and stung apples by codling moth during various periods and the entire season, 1948.

Treatment Number	Apples dropped to September 11			Harvest Counts September 14			Summary (Entire Season)			
	Total per plot	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Per cent clean
1	528	93.75	0.38	91	64.83	13.19	619	89.50	2.26	8.24
2	684	5.26	8.19	256	2.13	10.55	940	4.57	8.83	86.60
3	82	2.44	2.44	112	1.79	3.57	194	2.06	3.09	94.85
4	100	6.00	7.00	182	5.49	9.89	282	5.67	8.87	85.46
5	118	27.97	7.63	120	45.00	2.50	238	36.56	5.04	58.40
6	243	30.04	7.82	547	24.86	6.03	790	26.46	6.58	66.96
7	365	4.11	2.19	988	4.25	1.52	1353	4.21	1.70	94.09
8	102	11.77	1.96	254	5.11	2.77	356	7.02	2.53	90.45
9	344	29.07	26.45	329	7.30	3.95	673	18.43	15.45	66.12
10	84	9.52	1.19	161	6.21	6.21	245	7.35	4.49	88.16
11	552	38.95	5.98	510	11.76	11.57	1062	25.90	8.66	65.44
12	302	1.32	0.00	619	2.10	0.97	921	1.85	0.65	97.50
13	286	26.58	5.94	218	12.84	7.34	504	20.63	6.55	72.82
14	114	30.70	6.14	122	28.69	8.20	236	29.66	7.20	63.14
15	324	3.40	1.85	116	3.45	0.00	440	3.41	1.36	95.23
16	103	0.00	0.97	113	0.88	0.00	216	0.46	0.46	99.08
17	523	6.88	3.63	337	4.45	4.45	860	5.93	3.95	90.12

Discussion

Seven of the seventeen insecticide combinations in control plots (Table 2) gave excellent codling moth control with 90.12 to 99.08 percent clean fruit per plot for the entire season. A check plot received no insecticide sprays and resulted in 8.24 percent clean fruit.

Four and five DDT combination sprays as applied under conditions of the tests do not satisfactorily control codling moth under northeast Kansas conditions.

Spray injury to leaves was apparent in the Rhothane plus CR-1639 plot, in the Black Leaf 155-DDT plus summer oil emulsion plot, and the DDT plus IN-4200 plot as early as July 15. The injury in the Rhothane plus CR-1639 plot was caused by too high a dosage of CR-1639 while the injury in the Black Leaf 155-DDT plus summer oil plot was caused by the DDT-oil combination. Russet injury to the fruit in the plot sprayed with DDT plus IN-4200 was first found in July. By the time the fruit was harvested on September 14, every apple on the trees in the plot was covered from 30 percent to 100 percent with russet. Russet was not found on any of the apples in any of the other sixteen treatments.

The overwintering population of two-spotted mites in all test plots was large and these mites, aided by warm, dry weather in May and June increased rapidly in numbers. A serious outbreak of two-spotted mites was expected. However, frequent rainfall and cool nights during the summer following June 15 aided in the control of the mites so that control measures were unnecessary in orchards.

Damage by larvae of the red-banded leaf roller to the leaves or fruit did not occur in any of the test plots.

MASSACHUSETTS

A. I. Bourne, Massachusetts Agricultural Experiment Station, Amherst.

Experiments for Control of Codling Moth and Red Mite in Massachusetts, 1948

This summarizes tests in a block of the Experiment Station orchard containing the two varieties, McIntosh and Baldwin, in which a lead arsenate schedule was followed throughout the season, with a combination of Fermate 1/2 pound and micronized sulfur 3 pounds as the fungicide.

The standard schedule of applications recommended for apples in this State was followed, including two preblossom sprays, calyx, and five cover sprays. For the first time the application, previously designated "Emergency A" interposed between the second and third cover sprays, timed especially for codling moth control, was incorporated in the regular State schedule and became the official third cover scheduled normally to be applied about June 20. Lead arsenate was used in the pink and fourth cover sprays at 3 pounds; in the calyx, first, second and third cover sprays at 4 pounds; and at 2 pounds per 100 gallons in the fifth cover (for maggot control).

McIntosh at harvest showed 92% fruit free from insect or disease blemishes, 1 to 1½% scarred by curculio; 1½ to 3% damaged by codling moth; and 2 to 3 % by apple scab. Red Bug scarred 2% of the fruit.

In plots where Parathion (at 12 oz. of 25% w.p.) was applied in the Pink spray, fruit showed 2.8% injury by Red Bug. When this material was applied in the Calyx, the amount of damage was reduced to a trace (6 apples in 1800).

Fruit from unsprayed check trees in the same block showed 34% injury by curculio, 66% by codling moth, 40% by apple scab, and 6% scarring by red bug.

In the portion of the orchard where Parathion was applied, no appreciable infestation of either apple aphids or leaf hoppers developed during the season.

Red Mite

No dormant treatment was applied in this orchard. Between the Pink and Calyx sprays a moderate infestation of red mite developed. On May 19 between the Pink and Calyx sprays, examination showed that in the plot in which Parathion was included in the Pink application, one specimen of red mite was found on 25 spur clusters. Many basal leaves showed dead and shriveled mites and a few dead aphids. No living aphids were found on those trees. In the remainder of the orchard, red mites were found at the rate of 1161 for 25 spur clusters. A few eggs also were found. A moderate infestation of aphids had also developed.

Each succeeding application of Parathion (Calyx, 1st and 2nd Cover) reduced red mite to a very low level, although in every plot except where Parathion was used in the Pink, a moderate number of eggs could be found.

Hot dry weather during the summer apparently favored mite development and by late July foliage in parts of the orchard began to show considerable bronzing.

Counts made July 22 showed 4463 mites on 50 leaves in that section where no miticide had been used. Serious bronzing was present here. Where Parathion was applied in Pink spray only, counts showed 108 mites per 50 leaves and no bronzing. In the section where Parathion was first used in Calyx and none thereafter, 6185 mites per 50 leaves were found (the foliage was also seriously bronzed). Where Parathion was applied in Calyx and 1st or 2nd covers, mite infestation was 240 per 50 leaves, and no bronzing was noted.

Apparently the timing was a determining factor. Parathion in the Pink evidently eliminated the mites after the overwintering eggs had hatched and before mites had matured and deposited eggs for later broods. Parathion showed little if any effect upon eggs and its period of effectiveness apparently was not long enough to kill many young mites from eggs present at the time of application.

MICHIGAN

H. L. King and Ray Hutson, Michigan State College, East Lansing.

1948 Work on the Control of Codling Moth and Associated Pests

In the Palmer Orchard at Leslie, Michigan, a randomized block lay-out, using 23 single-tree replicates for each of five treatments, was set up. It included Cortland, Snow and Jonathan varieties. Standard treatments of lead arsenate and wettable sulfur were applied by the owner of the orchard during the pre-bloom and calyx period. Beginning with the first cover and continuing through the fifth, experimental sprays of lead arsenate, DDT and parathion were applied. The five cover sprays were started on June 2, June 14, June 24, July 6 and July 29. In the first three cover sprays, six pounds of wettable sulfur were added to each application, including the check. No fungicide was used in the last two applications. Maximum temperatures on the dates of application ranged from 60 to 87 degrees F. Relative humidity at 1:30 p.m. on the dates of application ranged from 36 to 90 percent. All treatments were applied with standard orchard equipment and all spraying was done from the ground.

At harvest time the yield of each tree was recorded and 100 apples from each tree were scored for insect injury. Treatments and results, in terms of percent of apples entered by codling moth larvae, are tabulated below. Each figure represents the average of 23 single tree plots.

Treatment	Percent of Apples Entered by Codling Moth Larvae[1/]
2.5 lb. of 25% parathion	0.0
1 lb. of 25% parathion	0.5
3 lb. lead arsenate, 1 lb. zinc sulfate, 4 lb. lime	1.0
2 lb. 50% DDT	0.4
Check	1.1

1/ At odds of 19 to 1, the significant difference between treatments is 0.5 percent.

The following items were reported at the 1948 meeting of the American Association of Economic Entomologists at New York City.

1. Parathion and lead arsenate, at the concentrations mentioned above, gave good control of red-banded leaf roller. DDT was less effective, but significantly better than the check treatment.

2. Parathion, at 2 1/2 pounds, caused some fruit and foliage injury on practically every tree. At 1 pound, it caused only occasional slight injury. Foliage injury was characterized by the appearance of wilted, burned and curled terminals after the third cover spray. Fruit injury, which appeared after the fifth cover, was characterized by the spotting of Cortlands and Snows and the russeting of Jonathans.

3. Chemical analyses, made by members of the Section of Agricultural Chemistry, indicated that the parathion residue on fruits dropped to 0.5 p.p.m. within 25 days after the last cover spray. At harvest time (66 days after the last cover) no parathion could be found on the fruit.

MISSOURI

Lee Jenkins, Curtis W. Wingo and Wilbur R. Enns, Missouri Agricultural Experiment Station, Columbia.

1948 Results on Codling Moth and Other Orchard Insects and Mites

The number of plats for codling moth control was reduced in 1948 due to the fact that DDT has been giving excellent control of codling moths.

More attention was given to the European red mite, two spotted mite, red banded leaf roller and Forbes scale.

Experimental plats at the Gardner Orchard, McBaine, Missouri, were sprayed as indicated in the following report.

All plats were sprayed the same through the first cover. Lead arsenate plus fungicide in the first cover at the rate of 3 lbs. lead per 100 gallons.

Plat 1 — Second cover, 2 lbs. 50% DDT plus 4 lbs. Mike sulfur. Third, fourth, fifth and sixth covers, 2 lbs. 50% wettable DDT. Seventh cover, 2 lbs. 50% DDT plus 1 quart summer oil. Eighth and ninth covers, 2 lbs. 50% DDT plus 1 lb. bentonite plus 1 quart of summer oil.

Plat 2 — Second cover, 2 lbs. 50% Methoxychlor plus 4 lbs. Mike sulfur. Third cover through ninth covers, 2 lbs. 50% Methoxychlor.

Plat 3 — Same as Plat 2 except 1/2 lb. 25% Parathion added in seventh and ninth covers.

Plat 4 — Second cover, 4 lbs. lead arsenate plus 4 lbs. Mike sulfur and 3 lbs. brown sugar. Third through the eighth covers, 3 lbs. lead arsenate, 3 lbs. brown sugar and 1 lb. of Safe-N-Lead. Ninth cover, 2 lbs. of 50% DDT plus 2 lbs. of C800.

Plat 5 — Second cover, 2 lbs. 50% DDT plus 4 lbs. Mike sulfur. Third through the ninth covers, 2 lbs. 50% DDT.

Plat 6 — Same as Plat 5 except 1/2 lb. of 25% Parathion added to the last three covers.

Plat 7 — Second cover, 1-1/8 lbs. 25% Parathion plus 4 lbs. Mike sulfur. Third through the ninth covers, 1-1/8 lbs. 25% Parathion.

RESULTS AT THE GARDNER ORCHARD ON CODLING MOTH CONTROL

Plat No.	Number of Apples Checked	% Wormy	% Stung	% Clean
1	750	.8%	1.1%	98.1%
2	750	.5%	0	99.5%
3	750	.5%	.1%	99.4%
4	750	8.5%	20.0%	71.5%
5	750	.6%	.4%	99.0%
6	750	0	0	100%
7	750	.13%	.13%	99.7%

There was a noticeable increase in russet and some spotting of the fruit due to the heavy schedule of Parathion in Plat 7. Apparently some of the injury was caused by the last few applications.

When Parathion was used at the rate of 1/2 lb. of 25% wettable powder in 100 gallons in the three last covers it did not cause any injury to the fruit or foliage.

The addition of one quart of summer oil to the last three cover sprays of DDT in Plat 1 caused considerable spotting of the fruit resembling oil injury.

The combination of lead arsenate and brown sugar in Plat 4 caused severe injury to the foliage.

MITES

Several materials were tested for the control of the two spotted mite and the European red mite.

Among those tested were C800, IN4200, DN111 and Parathion.

C800, IN4200, Parathion and DN111 all gave good control of mites. However there was severe russeting of the fruit of golden delicious where one application of 2 lbs. of C800 per 100 gallons was made on

July first. There was very little difference between the control from the use of DN111 at 1-1/4 lbs. as compared to 1/2 lb. of 25% Parathion.

RED BANDED LEAF ROLLER

Lead arsenate in the early sprays starting in the calyx at 3 lbs. per 100 gallons and continuing through the third cover gave fair control of the red banded leaf roller. Most of the damage was done to Missouri apples after mid September. Leaf roller larvae were present on apples in the orchard till mid November.

SCALE

Forbes scale is now the most important of the scales in Missouri apple orchards. It can be found in practically every orchard where DDT has been used.

Parathion, 2-1/4 lbs. of the 25% powder in 100 gallons, was applied to a heavy infestation of Forbes scale on August 11. Counts on August 26 indicated 83% kill.

One per cent summer oil applied the same date as the Parathion gave a count of 87% kill on Forbes scale.

New Jersey

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Codling Moth, European Red Mite and Red-Banded Leafroller on Apples

Since the general use of DDT for codling moth control has come about in apple orchards of central and southern New Jersey, this insect has been greatly reduced in population. It is getting difficult to locate a heavily infested orchard where one can hand for larvae for maintaining cages, etc. European red mite has become the primary problem in orchards sprayed with DDT and, for the first time, red-banded leafroller has come into the picture as a pest to be reckoned with.

Red-banded leafroller built up to damaging numbers in several orchards in central and southern New Jersey in 1948. An extensive survey showed that those orchards where leafroller became a problem during July, August and September were orchards where the use of lead arsenate had been cut down to one or two sprays (petal fall and first cover). Where lead arsenate was included in 4 or more sprays as recommended, leafroller was not a serious problem.

Apple spraying experiments in 1948 were confined to testing promising mite control materials and red-banded leafroller control.

European Red Mite Control on Delicious Apples Following DDT Sprays for Codling Moth Control

Samples of most of the promising insecticide formulations designed for mite control during the growing season were assembled at Glassboro. It was planned to compare these with DN-111, a more or less standard material for the control of growing season infestations of mites on apples. A block of Red Delicious in the orchard of Ralph Mecouch at Glassboro was selected. This orchard was sprayed for codling moth during May and June with lead arsenate and DDT. It was planned to wait until the mites had built up to a point just short of bronzing, then go in with the various materials and see if the mites could be brought under control and which materials, if any, showed residual action. This would represent what the average fruit grower would do--wait until mite populations were high before spraying. Few growers are inclined to add a mite control material in every spray more or less as insurance to keep mites down.

Single tree plots were used replicated three times. The sprays were applied with a single nozzle gun, the trees being sprayed from the ground underneath and outside. On July 7th a check of the mite population showed from 20 to 60 mites per leaf with numerous eggs and small nymphs. On July 8th nine plot treatments were applied. An unsprayed check plot of three trees was included in the plot set-up.

To determine the results of the spray treatments, counts of live mites on leaves were made 1, 6, 12 and 19 days after treatment. A headpiece magnifier (5X) was used and only the adult mites and larger nymphs were recorded. The magnification used was not great enough to see the eggs and recently hatched nymphs. In making the counts 5 leaves were picked at random from each tree and the live mites recorded. Since there were 3 trees in each treatment this gave 15 leaves examined per treatment. Two investigators made independent counts, thus 30 leaves were examined for each treatment at the intervals indicated following the spray applications. The results obtained from these experiments are set forth in table 1.

Table.1. European red mite control on Red Delicious trees receiving various mite control materials. Treatments applied July 8th.

Plot No.	Treatment*	Number Mites per 100 Leaves on: July 9	July 14	July 20	July 27
1	IN-4200 1 pint	92	387	1076	2693
2	DN-111 1-1/4 pounds	33	73	667	2264
3	Parathion (25% wettable) 1 pound	6	3	297	2020
4	S.W.Dimite, 1 pint	6	3	1178	1650
5	Hexicide 1/2 pint	0	600	2168	1577
6	Neotran 2-1/2 pounds	100	33	1237	2627
7	G.C. #923 1 pint	87	178	1458	3749
8	G.C. #876 2 lbs.	48	24	1112	2706
9	C. & C. #2 1 quart	64	172	1782	3313
10	Check (no treatment)	710	1277	3500	4098

*Amounts per 100 gallons water.

The data in table 1 show that all of the mite control materials reduced the mite population down to one or two mites or less per leaf the day after the sprays were applied. After six days the Hexicide, IN-4200, General Chemical #923 and Carbide and Carbon #2 all showed an upsurge in mite populations indicating little egg killing or residual action. The formulation of Parathion, Dimite, Neotran, General Chemical #876 and DN-11 were still low on mite populations indicating some residual action or egg killing or both. By July 20, twelve days after the spray treatments were applied, mite populations were building up on all treatments with the Parathion formulation showing the lowest mite count per leaf. Nineteen days after treatments were applied all plots showed mite populations build up to a point where additional spraying would have been necessary.

The conclusion to be drawn from these experiments is that none of the materials tested was capable of cleaning up a heavy summer infestation of European red mite and holding the mites for the remainder of the season with only one spray application. It should be pointed out, however, that with the single tree plot set-up there is a possibility of reinfestation from unsprayed check plots or from poor control treatments. On a whole orchard or large block treatments some of the materials may have held up longer than they did in these experiments.

Control of Red-Banded Leafroller on Apples

During the first week in July a series of plots were set up in a block of Red Delicious in the orchard of Mr. Ralph Mecouch to study the control of European red mite which had built up following a DDT schedule. Ten different materials were used on a one-tree plot set-up replicated three times. An untreated check was included. The plots were sprayed once on July 8th, using a single nozzle gun, the trees being sprayed underneath and outside. At the time the plots were sprayed it was noted there was considerable leafroller injury present. A check-up with the grower disclosed that lead arsenate had been left out of the cover sprays for codling moth during June, DDT being used alone. The time (July 8th) and the stage of the larvae present on the leaves indicated second brood leafroller was getting underway.

Following the one spray application July 8th, mite counts were made on the different plots up to July 20th. It was observed during this period that leaf-

roller injury increased on some of the plots but not on others. It seemed advisable to make a count of leafroller injury on the various plots. This was done on August 1st to 5th. The method used was to examine all leaves on ten terminals on each tree in each plot and record the number of leaves showing leafroller injury. Thus, with three trees in each plot treatment, there were 30 terminals examined for each plot treatment. The injured leaves recorded included both first and second brood leafroller injury. The results obtained from these examinations are set forth in table 1.

Table 1. Red-banded leafroller injury on Red Delicious sprayed with different materials. Number injured leaves on 30 terminals per treatment.

Plot No.	Treatment (in 100 Gallons)	Number Injured Leaves on 30 Terminals
1	IN-4200 1 pint	225
2	DN-111 1-1/4 lbs.	244
3	Thiophos 3422 (25%) 1 lb.	37
4	Dimite 1 pint	210
5	Hexicide 1/2 pint	236
6	Neotran (C 800) 1 lb.	203
7	Gen. Chem. #923 1 pint.	145
8	Gen. Chem. #876 2 lbs.	274
9	Carbide & C arbon #2 1 quart	238
10	Check (no treatment)	262

The data in table 1 show that the Parathion (plot 3) was the only treatment which reduced leafroller injury to a marked degree over the untreated check. The reduction in leafroller injury by the Thiophos 3422 was great enough to warrant further experiments with this material against third brood red-banded leafroller.

Experiments to Control Third Brood Red-Banded Leafroller

In the same orchard (Mecouch) where the data in table 1 was obtained a set of plots were laid out to test Parathion, Rhothane (DDD), lead arsenate and DDT as a control for third brood red-banded leafroller. These materials were selected because Rhothane, both the emulsion and wettable powder, had been reported from Virginia and West Virginia as being effective. Lead Arsenate was used because it had proved an effective control material when used against the first brood of leafroller. Included in the plot set-up was DDT at 4 pounds of 50% wettable powder to 100 gallons water because the New York Experiment Station investigations had reported this dosage effective against leafroller.

Single tree plots replicated four times (2 Red Delicious and 2 Rome) were used/ Treatments were applied on September 1st which was estimated as the proper time to spray for the third brood of leafroller larvae. Two of the plots (1 and 7) were sprayed a second time on September 9th to determine if more than one spray was necessary to obtain control.

The Red Delicious apples were picked too soon after treatments were applied to obtain any worthwhile data. The Romes, however, were not harvested until October 11th. On September 15th all dropped apples were picked up under the Rome trees and discarded because it was figured drops up to that time would have fallen

due to second brood leafroller injury occurring before the sprays were applied. Dropped apples were collected on September 27th and October 11th and examined for leafroller injury. Fruit remaining on the trees were harvested October 11th. The drops of September 27th and October 11th were combined with the picked fruit of October 11th. The data obtained are set forth in table 2.

Table 2. Red-banded leafroller control, Rome apples. Plots sprayed September 1st. Harvested October 11th.

Plot No.	Treatment (in 100 Gallons)	Total Apples	Leafroller Injured Apples	% Apples Injured
1	Rhothane (25%) 1 quart	1056	36	3.4
2	Rhothane (50%) 2 lbs.	1771	64	3.6
3	Rhothane (25%) 1 quart	486	20	4.9
4	Rhothane (50%) 2 lbs.	592	24	4.0
5	Lead arsenate 3 lbs.	752	20	2.6
6	DDT (50%) 4 lbs.	555	82	14.7
7	Parathion (25%) 1 lb.	838	43	5.1
8	Check (no treatment)	872	153	17.5

The data in table 2 show that all of the treatments gave a measure of control except the DDT. One spray was as effective as two sprays because plots 1 and 7 were sprayed a second time on September 9th (all plots sprayed September 1st) and no improvement in control was noted.

Leafroller Injury Related to Spray Schedule Followed

During July and August, 1948 several apple orchards in the Glassboro area developed rather severe red-banded leafroller injury on the foliage and fruit. In these orchards it became necessary for the growers to use extra spray measures to prevent further build-up and damage of fruit. For the most part, lead arsenate and Rhothane (DDD) were used. In other orchards in the same area no leafroller could be found and in still others leafroller was very light.

A survey of orchards in the Glassboro-Richwood area was made during August to determine whether there was any relationship between the amount of leafroller injury and the spray schedule followed, especially as regards the number of lead arsenate sprays used where a DDT schedule had been depended upon primarily for codling moth control. It might be added that in the so-called DDT schedule for codling moth control lead arsenate had been recommended in the pink, petal fall, first, second and fifth cover sprays to take care of certain insects, such as the red-banded leafroller, which experience had shown tend to build up following a DDT schedule.

A total of 20 orchards were surveyed in the Glassboro-Richwood area. The information asked was whether or not lead arsenate and/or DDT was used in the pink, petal fall and each of the cover sprays up to and including the seventh cover spray. Leafroller injury was scored in the various orchards as "none", "very light", "light" and "medium". Since the injury present on fruit and foliage in August was the result of first and second brood larval attack and third brood attack would not appear until September and October it was probable that the

orchards scored as "moderately" infested in August would score as "severe" in October if no control measures were undertaken.

Another question asked was whether DDT had been used in a given orchard one or more years. Perhaps the continued use of DDT over a period of years had resulted in a build-up of leafroller.

The data obtained in this survey, set forth in table 3, show that the severity of leafroller injury was associated with the failure to use the recommended number of lead arsenate sprays. The Mecouch, Higgen, F. Schober, Jr. and Wilson #2 orchards all used no more than one or two sprays of lead arsenate. Those orchards using from 3 to 5 sprays of lead arsenate were in good shape as far as leafroller injury was concerned. There appeared to be no relationship between the length of time DDT was used and the amount of leafroller injury.

Table 3. Survey of orchards in regards to red-banded leafroller injury and the relationship between the use of lead arsenate and DDT.

Grower	Pink	Petal Fall	1st Cover	2nd Cover	3rd Cover	4th Cover	5th Cover	6th Cover	7th Cover	Leafroller Injury	No. Years DDT Used
H. Heritage	-	L.A.	LA.	L.A.	L.A.	L.A.	DDT	DDT	-	None	First
J. Reuter	-	L.A.	L.A.	L.A.	L.A.DDT	L.A.DDT	L.A.	L.A.	-	None	Second
Scholl Bros.	-	L.A.	L.A.	L.A.	L.A.	L.A.	DDT	DDT	-	Very light	Third
F. Sander	-	LA. DDT	L.A.DDT	L.A.DDT	DDT	L.A.DDT	L.A.DDT	L.A.DDT	-	Very light	Third
W. Zee	-	L.A.	L.A.	L.A.	DDT	DDT	DDT	-	-	Very light	Third
Y. Magee	-	L.A.	L.A.	L.A.	L.A.	DDT	DDT	DDT	-	Very light	Second
W. Schober	-	L.A.	LA.	L.A.	DDT	DDT	L.A.	DDT	-	Very light	First
Lamb	-	L.A.	L.A.	L.A.	DDT	DDT	DDT	-	-	Light	Third
Russo	-	L.A.	L.A.	L.A.	L.A.	Oil	DDT	DDT	-	None	Third
Russo	-	L.A.	L.A.	-	-	-	DDT	DDT	-	Light	Third
J. Houck	-	L.A.	L.A.DDT	DDT	-	L.A.	DDT	-	-	Light	Third
J. Heggan	-	L.A.	-	DDT	DDT	DDT	DDT	L.A.	-	Moderate	Second
R. Mecouch	-	L.A.	DDT	DDT	DDT	DDT	DDT	DDT	-	Moderate	Third
F. Corsoro	L.A.	L.A.	L.A.	DDT	DDT	DDT	L.A.DDT	DDT	DDT	Light	Second
F. Schober,Jr.	-	L.A.	L.A.	DDT	DDT	DDT	L.A.	DDT	DDT	Moderate	Third
F. Schober,Jr.	-	L.A.	L.A.	L.A.	DDT	DDT	DDT	DDT	DDT	Moderate	Third
Roth	L.A.	L.A.	L.A.	L.A.	L.A.	DDT	DDT	DDT	-	None	First
H. Router	-	L.A.	L.A.	L.A.	DDT	DDT	DDT	-	-	Very light	First
Wilson #1	-	L.A.	L.A.	L.A.	L.A.	L.A.	DDT	-	-	Light	Second
Wilson #2	-	L.A.	DDT	DDT	DDT	DDT	DDT	-	-	Severe	Second

NEW YORK

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Codling Moth

Experimental work was carried on to determine the possible place of parathion in the summer spray program on apples. Comparisons were made with standard spray schedules using DDT and lead arsenate. Five sprays were applied as follows: 6/21, 7/2, 7/14, 8/4 and 8/16. Each treatment was replicated three times. The results are as follows:

Material and Amount per 100 Gallons	Percent Wormy	
	First Brood	Harvest
50% DDT 2 lb.	0.2	1.9
50% DDT 1 lb.	0.6	7.8
Lead arsenate 3 lb.	0.8	11.4
25% Parathion 2 lb.	0.9	15.4
25% Parathion 1 lb.	0.4	17.0
25% Parathion 1 lb. in sprays 1 and 2 50% DDT 2 lb. in 3, 4 and 5	0.4	2.7
Lead arsenate 3 lb. + 25% parathion 1/2 lb.	0.0	3.9
Check	30.7	67.1

It is apparent that parathion is effective against the codling moth as long as sufficient residues are present. It was not until about two weeks after the last application that many entries were noted. A season favoring late codling moth development accentuated this condition. Residue analyses were made for parathion at harvest. All of the samples had less than 0.1 p.p.m., the highest being 0.09 p.p.m. for the plot receiving 2 pounds of 50 percent wettable powder throughout the full schedule.

McIntosh and Cortland trees were used in the experiment. Parathion caused little or no foliage injury but very definite fruit injury at all three concentrations, being very light at 1/2 pound dosage. Injury started at spots where spray droplets formed and the deposit was heavy. Early in the season the skin turned brown at these points and later as the fruit grew, the injured spot became sunken giving a pitted effect. Also, fruit color was poor on injured fruit. Injury was uniform over all trees in the parathion plots and over each tree.

Red-Banded Leaf Roller

This pest was again present in epidemic proportions, particularly in certain orchards. The first brood was serious enough to cause up to 50 percent fruit injury on certain unsprayed check trees. The second brood again caused considerable premature dropping in orchards where proper control measures were not carried out. Commercial injury ranged from practically none in a few orchards to a complete loss. A first brood test was made in a R. I. Greening orchard that had a very heavy carry-over from 1947. The results were as follows:

Material and Amount per 100 Gallons	Applications				Percent Fruit Injury (First Brood Only)
	Pink	Calyx	10-Day	First Cover	
Lead arsenate 3 lb.	x	x	x	x	9.5
Lead arsenate 3 lb.	.	x	x	x	19.1
Lead arsenate 3 lb.	.	.	x	x	35.9
Lead arsenate 3 lb.	.	.	.	x	51.8
50% DDT 2 lb.	x	x	x	x	4.1
50% DDT 4 lb.	x	x	x	x	1.6
25% Parathion 1/4 lb.	.	x	x	.	0.2
Petroleum Oil 1/ 1%	x	.	.	.	10.6
Check	.	.	.	.	42.1

1/ Superior dormant type emulsified with blood albumin.

A second brood test was made in another R. I. Greening orchard. Two sprays were applied, timed to coincide with the beginning of egg hatching (July 28) and 12 days later (August 9). Counts were made at harvest. Fruits were scored for injury and also for the number of feeding areas per fruit--a record comparable to the number of codling moth worms per apple. The results are given as the number of feeding areas per 100 fruit.

Material and Amount per 100 Gallons		Feeding Areas per 100 Apples
25% Chlorinated camphene	3 lb.	15.1
50% Methoxychlor	3 lb.	25.1
50% Chlordane	2 lb.	59.6
20% TEPP	1 pt.	47.7
50% DDD	3 lb.	0.1
Lead arsenate	3 lb.	0.6
50% DDT	3 lb.	10.6
25% Parathion	1/2 lb.	4.8
Check		68.2

NEW YORK (Continued)

R. W. Dean, New York Agricultural Experiment Station, Poughkeepsie.

Orchard Mites

Overwintering eggs of the European red mite were scarce in most orchards, the only heavy infestations found being in northern Columbia County. Most growers applied oil in the green-tip or delayed dormant sprays and, consequently, there was no build-up until late July or early August in many orchards. Unoiled trees were noticeably infested by early May but unfavorable weather conditions slowed mite increase until the latter part of June. In general, control of the European red mite was not difficult even where DDT was used.

Survival of hibernating two-spotted spider mites under bark on apple trees was greater than has been noted previously. Hibernating mites were found crawling actively on trees on March 31 in one orchard. On April 20, no mites were found on the opening buds but clover growing in the orchard was well infested and many eggs had been laid. By May 6, some buds on spurs close to the trunks were heavily infested and the foliage was bronzed. Weeds and clover growing in the orchard were also infested. Unfavorable weather conditions prevailed from mid-May until July, and the build-up of two-spotted mites stopped. By May 24, populations on the infested trees and the orchard cover had decreased noticeably and continued to decline until they practically disappeared. Through July, August and September, hot dry weather occurred and during this period the two-spotted mite became very abundant. A build-up on the orchard cover was first noted in late June and early July and by the latter part of July they were appearing in numbers in the trees. The infestations reached such proportions in some orchards that the growers were unable to hold them in check with repeated applications of dinitro materials, TEPP or parathion.

Tests for control of European red mite were made in a block of Golden Delicious which had not been sprayed with oil in the spring. The first application was made June 25 and most materials were applied a second time on July 6. Mite populations were measured by brushing 25 leaves from each of 3 trees in each plat and counting all mites and eggs in each sample. The first leaf sample was taken immediately before the first application was made, the second one 11 days later, just before the second spray application, and thereafter at intervals of 21, 32 and 42 days after the original sampling. The materials tested and results obtained are shown in Table 1. Results are shown as numbers of mites and eggs per 75-leaf sample and as percent of the original population found in the June 25 count.

Treatment 2 (DMC) was applied only on June 25. Only the first application of Treatment 12 (IN-4200) was made as considerable spray injury was noted 5 days later. This was in the form of yellowing and dropping of foliage, particularly smaller leaves. Some larger leaves showed brown, burned areas where spray had collected. Considerable yellowing of leaves occurred in Plat 6 and slight amounts in Plats 5, 7 and 10. Typical dinitro burning developed in Plats 1, 9 and 10 but it did not become serious. No treatment caused injury involving the fruit except No. 3 (C-800) which gave considerable russetting.

Control with C-800 and IN-4200 was good after the first application, but most materials show peak effectiveness in the 21-day count. Controls were beginning to deteriorate at the end of 32 days, and by the 42d day, only the C-800 plat had a lower percentage of mites than the check, altho all treatments showed lower populations than they originally had had. Some two-spotted mites had begun to appear on the trees but they were few in numbers.

A second series of tests, involving both European red mite and two-spotted mite was made in an orchard containing Baldwin, McIntosh, Northwestern Greening and Red Delicious trees. The first spray application was made on July 29 and all treatments were repeated on August 9. Counts were made on samples of 25 leaves from each of 4 trees in each plat before spraying on both of these dates and also on the 21st, 32d and 42d days following the original count. Materials and results are given in Table 2.

No spray injury was noted on the apples or on single Elberta peach trees which were sprayed with the test materials. Treatment 5 showed a high kill of mites after a single application, as did Treatment 3, but most materials gave maximum control only after the second application. At the 32-day count, Plats 2, 4, 5 and 8 still showed better than 90% control efficiency as compared to the check, where the mites had more than doubled in number. This increase, which occurred thruout most of the test period was largely due to the movement of two-spotted mites into the trees. By the 42d day, all controls had deteriorated, the highest (Plat 2) being 45%, while Treatments 3, 6, 7 and 9 showed no control. In all plats, the mite populations exceeded the original numbers.

Table 1. Control of Summer Forms of European Red Mite

Plat No.	Treatment (Amounts shown are for 100 gals.)	Stage	June 25	July 6		July 16		July 27		Aug. 6	
			No.	No.	%[1]	No.	%[1]	No.	%[1]	No.	%[1]
1.	DN-111[2] 1¼ lb.	Mites	198	167	84.34	6	3.03	123	62.12	96	48.48
		Eggs	1078	334	30.98	58	5.38	377	34.97	196	18.18
		Total	1276	501	39.26	64	5.02	500	39.18	292	22.88
2.	Dimite[3] 1 pt.	Mites	142	90	63.38	32	22.53	154	108.45	129	90.84
		Eggs	988	56	5.67	219	22.16	174	17.61	362	36.64
		Total	1130	146	12.92	251	22.21	328	29.03	491	43.45
3.	C-800[4] 2½ lb.	Mites	222	77	34.68	4	1.80	61	27.48	66	29.73
		Eggs	1237	46	3.72	20	1.62	81	6.55	96	7.76
		Total	1459	123	8.43	24	1.64	142	9.73	162	11.10
4.	25% Parathion w.p. 5 oz.	Mites	147	452	307.48	13	8.84	18	12.24	128	87.07
		Eggs	1185	31	2.62	7	0.59	125	10.55	98	8.27
		Total	1332	483	36.26	20	1.50	143	10.74	226	16.97
5.	ME-37[5] ¼-½ pt.	Mites	109	227	208.26	32	29.36	67	61.47	131	79.82
		Eggs	657	18	2.74	9	1.37	189	28.77	380	57.84
		Total	766	245	31.98	41	5.35	256	33.42	511	66.71
6.	83-N[6] 1 pt.	Mites	71	184	259.15	16	22.53	72	101.41	148	205.45
		Eggs	586	47	8.02	38	6.48	248	42.32	287	48.98
		Total	657	231	35.16	54	8.22	320	48.71	435	66.21
7.	L-48[7] 2 lb.	Mites	190	422	222.11	36	18.95	125	65.79	89	46.84
		Eggs	1010	167	16.53	301	29.80	227	22.47	432	42.77
		Total	1200	589	49.08	337	28.08	352	29.33	521	43.42
8.	Check	Mites	148	863	583.11	616	416.22	808	545.95	58	39.19
		Eggs	731	226	30.92	1431	195.76	722	98.77	41	5.61
		Total	879	1089	123.89	2047	232.88	1530	174.06	99	11.26
9.	Cr-1639[8] pwd. 22 oz.	Mites	177	264	149.15	10	5.65	93	52.54	76	42.94
		Eggs	1099	195	17.74	45	4.09	203	18.47	427	38.85
		Total	1276	459	35.97	55	4.31	296	23.20	503	39.42

Table 1. continued

Plat No.	Treatment (Amounts shown are for 100 gals.)	Stage	June 25	July 6		July 16		July 27		Aug. 6	
			No.	No.	%[1]	No.	%[1]	No.	%[1]	No.	%[1]
10.	Cr-1639[8] emuls. 22 oz.	Mites	90	80	88.89	5	5.55	50	55.55	101	112.22
		Eggs	478	24	5.02	20	4.18	157	32.84	135	28.24
		Total	568	104	18.31	25	4.40	207	36.44	236	41.55
11.	Toxaphene Emuls.[9] 1 pt.	Mites	433	987	227.94	41	9.47	177	40.88	192	44.34
		Eggs	1629	45	2.76	53	3.25	363	22.28	272	16.69
		Total	2062	1032	50.05	94	4.56	540	26.19	464	22.50
12.	IN-4200[10] 1 pt.	Mites	90	31	34.44	53	58.89	87	96.67	168	186.67
		Eggs	400	7	1.75	23	5.75	307	76.75	160	40.00
		Total	490	38	7.76	76	15.51	394	80.41	328	66.94

[1]% of original population.

[2]Dicyclohexyl amine salt of dinitro-o-cyclo-hexyl phenol 20%. Dow Chemical.

[3]Dichloro phenyl methyl carbinol 25% emulsion. Sherwin-Williams.

[4]Dichlorophenoxy methane 40%. Dow Chemical.

[5]Tetraethyl pyrophosphate ?%. Niagara Sprayer & Chemical.

[6]Aryl alkyl sulfonate. Naugatuck Chemical.

[7]Chloroethyl chlorobenzene sulfonate 25%. Naugatuck Chemical.

[8]Dinitro capryl phenyl crotonate 25%. Rohm & Haas.

[9]Chlorinated camphene 50%. Hercules Powder.

[10]Lorol-2-thiazolinyl sulfide. DuPont.

Table 2. Control of Summer Forms of European Red Mite and Two-Spotted Mite

Plat No.	Treatment (Amounts shown are for 100 gals.)	Stage	July 29	Aug. 9		Aug. 19		Aug. 30		Sept. 19	
			No.	No.	%[1]	No.	%[1]	No.	%[1]	No.	%[1]
1.	Check	Mites	571	1415	247.81	1420	248.69	2427	425.04	2130	373.03
		Eggs	1138	79	6.94	1899	166.87	1312	115.29	1920	168.72
		Total	1709	1494	87.42	3319	194.21	3739	218.78	4050	236.98
2.	C-800[2] 2½ lb.	Mites	453	222	49.01	79	17.44	182	40.18	650	143.49
		Eggs	1379	52	3.77	85	6.16	109	7.90	1729	125.38
		Total	1832	274	14.96	164	8.95	291	15.88	2379	129.86
3.	C-800 1¼ lb. + DN-111[3] 10 oz.	Mites	590	94	15.93	82	13.90	603	102.20	1854	314.24
		Eggs	1172	44	3.75	57	4.86	222	18.94	3269	278.92
		Total	1762	138	7.83	139	7.89	825	46.82	5123	290.75
4.	DN-111 1¼ lb.	Mites	869	104	11.97	52	5.98	325	37.40	1165	134.06
		Eggs	1312	125	9.53	64	4.88	65	4.95	2358	179.73
		Total	2181	229	10.50	116	5.32	390	17.88	3523	161.53
5.	DN Dry Mix Wet. No.1[4] 6 oz.	Mites	553	31	5.61	51	9.22	394	71.25	1199	216.82
		Eggs	1949	8	0.41	76	3.90	108	5.54	2171	111.39
		Total	2502	39	1.56	127	5.08	502	20.06	3370	134.69
6.	C-800 1¼ lb. + DN Dry Mix Wet. No. 1 3 oz.	Mites	398	215	54.02	213	53.52	808	203.02	2253	566.08
		Eggs	1686	65	3.86	272	16.13	296	17.56	3234	191.81
		Total	2084	280	13.44	485	23.27	1104	52.98	5487	263.29
7.	25% Parathion w.p. 5 oz.	Mites	896	572	63.84	49	5.47	621	69.31	2324	259.38
		Eggs	960	13	1.35	22	2.29	156	19.25	3121	325.10
		Total	1856	585	31.52	71	3.83	777	41.86	5445	293.37
8.	Dimite[5] 1 pt.	Mites	345	223	64.64	40	11.59	129	37.39	1022	296.23
		Eggs	1095	33	3.01	9	0.82	79	7.21	1681	153.52
		Total	1440	256	17.78	49	3.40	208	14.44	2703	187.71
9.	Vapotone XX[6] ½ pt.	Mites	419	978	233.41	105	25.06	1045	249.40	3307	789.26
		Eggs	1199	12	1.00	34	2.84	708	59.05	2892	241.20
		Total	1618	990	61.19	139	8.59	1753	108.34	6199	383.13

[1] % of original population

[2] Dicyclohexyl amine salt of dinitro-o-cyclo-hexyl phenol 20%. Dow Chemical.

[3] Dichloro phenyl methyl carbinol 25% emulsion. SHerwin-Williams.

[4] Dinitro-o-cyclohexyl phenol 40%. Dow Chemical

[5] Tetraethyl pyrophosphate ?%. Niagara Sprayer & Chemical

[6] Tetraethyl pyrophosphate 20%. Calif. Spray-Chem.

Tests with materials in dust form were made in a Red Delicious orchard heavily infested with two-spotted mites. The first application was made August 10 and was followed by a second on all plats August 19. Population records, taken immediately before each dust application and at 20, 30 and 41-day intervals after the first, are based on counts of all mites and eggs on 25-leaf samples from each of four trees in each plat. These data, together with the materials tested are given in Table 3. Since the mite populations on check trees decreased to 3% of the originals during the period of the test, the results do not indicate the true efficiencies of the materials. All plats had higher mite populations than the check 30 days after the start of the test. Up to the end of the 20-day period, Plat 5 showed the most control and, at the final count, had the lowest population (7%) in terms of the original. The TEPP dust was second during the first 20 days, but the final count showed 15% of the original number of mites and eggs in this plat as compared to 9% in the plat treated with 2% parathion dust. No injury resulted to the trees from any of the materials used.

Table 3. Two-Spotted Mite Control with Dusts

Plat No.	Treatment	Stage	Aug. 10	Aug. 19		Aug. 30		Sept. 9		Sept. 20	
			No.	No.	%[1]	No.	%[1]	No.	%[1]	No.	%[1]
1.	Check	Mites	2870	1193	41.57	836	29.13	615	21.43	233	8.12
		Eggs	6853	1790	26.12	776	11.32	178	2.60	46	0.67
		Total	9723	2983	30.68	1612	16.58	793	8.16	279	2.87
2.	Vapotone Dust No. 66[2]	Mites	2022	821	40.60	173	8.56	669	33.09	1076	53.21
		Eggs	5881	59	1.00	56	0.95	435	7.40	88	1.50
		Total	7903	880	11.14	229	2.90	1104	13.97	1164	14.73
3.	2% Parathion dust	Mites	2506	1456	58.10	240	9.58	2551	101.80	924	36.87
		Eggs	8250	68	0.82	373	4.52	723	8.76	31	0.38
		Total	10756	1524	14.17	613	5.70	3274	30.44	955	8.88
4.	1% Parathion dust	Mites	1448	1159	80.04	416	28.73	2348	162.15	1802	124.45
		Eggs	2779	78	2.81	519	18.68	687	24.72	172	6.19
		Total	4227	1237	29.26	935	22.12	3035	71.80	1974	46.70
5.	DN Dust D-4[3]	Mites	3339	304	9.10	68	2.04	566	16.95	462	13.84
		Eggs	4484	339	7.56	153	3.41	130	2.90	69	1.54
		Total	7823	643	8.22	221	2.83	696	8.90	531	6.79

[1] % of original population.

[2] TEPP 0.66%. Calif. Spray-Chem.

[3] Dicyclo-hexyl amine salt of dinitro-o-cyclo -hexyl phenol 1%. Dow Chemical.

NORTH CAROLINA

C. F. Smith, North Carolina Agricultural Experiment Station, Raleigh.

Work on apple insects was primarily of a demonstrational nature.

Parathion was used at the rate of one pound of 25% wettable powder per 100 gallons of spray. At this concentration it was very effective against rosy and green apple aphids. It was effective against European red mite also but at least 2 applications were necessary for control.

The following are notes on a test block which used DDT, parathion and fermate or lime-sulfur throughout the season: Codling moth had been especially bad in 1947. The block of trees was sprayed as indicated below. Varieties were stayman winesap, magnum bonum and red delicious.

April 5	Apples were not quite in full bloom, about 50% of the codling moths were in the pupal stage.
April 14	Majority of the apples were ready for the petal fall spray.
April 15	Sprayed - DDT 2 lbs., lime-sulfur 6 qts.
April 22	Many moths had emerged, some larvae and pupae still present. Some of the late blooming varieties were about ready for the petal fall.spray.
April 27	Sprayed - DDT 2 lbs. - parathion 1 lb. - Fermate 1 1/2 lbs.
May 7	Many empty pupal cases were observed in the test block but no stings or entries were found in the apples.
May 10	Sprayed - DDT 2 lbs. - Fermate 1 1/2 lbs.
May 20	No wormy or stung fruit was observed in the test plot, however, there were several empty pupal cases on the trunk of trees indicating a heavy codling moth infestation. Some wormy fruit was observed in another section of the orchard and some of the worms appeared about 1/3 grown. European red mites were appearing on the leaves, averaging 1 to 2 per leaf in most of the orchard and averaging 2 to 3 in the test block. All of the orchard except test block had been sprayed with tetraethyl pyrophosphate .
May 21	Sprayed - DDT 2 lbs - parathion 1 lb. - Fermate 1 1/2 lbs.
June 1	European red mite had practically disappeared over all of the orchard.
June 10	Sprayed - DDT 1 lb - parathion 1/2 lb. - Fermate 1 lb.
June 22	Mites on test plot were nearly all young, averaging 3 to 5 per leaf. Mites in some other parts of the orchard were so abundant they were causing a bronzing of the leaves.
June 24	Sprayed - DDT 1 lb. - parathion 1/2 lb.
July 12	Test plot was still free of mites and codling moth stings.
August 24	Red banded leaf roller was very abundant in most of orchard, limited number in test plot.
August 25	Sprayed - DDT 1 lb. - parathion 1/2 lb.
Sept. 23	Test plot was practically free of mites, codling moth and leaf roller except on magnum bonum which did not receive the spray on August 25. This variety was severely damaged by leaf roller. The foliage on the test block appeared very healthy and the apples had a nice finish.

Parathion residue analyses made September 8 (apples picked August 30) indicated no parathion present. A sample picked September 23 had 0.15 ppm of parathion.

This orchard was located at Mt. Airy, N. C.

OHIO

C. R. Cutright, Ohio Agricultural Experiment Station, Wooster.

Apple Insect Control

The results of the past season may be summarized as follows:

1. Weather favored the codling moth with very warm periods during late June and early July and again from mid August to mid September.

2. DDT was fully as effective in controlling codling moth as in past seasons except in late season when weather conditions necessitated an additional spray application.

3. In codling moth problem orchards where DDT had controlled, a return to lead arsenate use resulted in severe damage by codling moth.

4. There are no indications that minimum schedules of one or two applications of DDT will give seasonal control of codling moth. Four or five applications are recommended.

5. Red-banded leaf roller was successfully controlled by combined sprays of lead arsenate and DDT. As emergency sprays, DDD and parathion were both used successfully.

6. European red mite is still the chief orchard problem. Summer dinitro (DN-111), dormant dinitro (Dry Mix No. 1), and HETP were used by growers with varying degrees of success. Due to price differential, Dry Mix No. 1 will probably be more widely used. As yet there is no ideal acaricide. Several acaricides at five and ten times normal concentrations were applied with concentrate sprayers and good control of mites obtained without injury to fruit or foliage.

7. The 17-year cicada was successfully controlled on young trees by the use of HETP and TEP at appropriate dosages.

OKLAHOMA

D. Ashdown, Oklahoma Agricultural Experiment Station, Stillwater.

Codling Moth Control

The work in Oklahoma was of a preliminary and survey nature in 1948. The season was favorable for codling moth activities and three generations developed. The following observations were made as to the efficiency of various spray programs:

1. DDT was superior to lead arsenate as a toxicant for codling moth control.

2. Spider mite infestations (Tetranychus spp.) usually followed use of DDT in the spray program, but infestations sufficient to cause leaf bronzing were also observed in some orchards where only lead arsenate was used for codling moth control.

3. Very thorough applications of DDT-containing sprays resulted in good spider mite control where populations had built up to a high level, and subsequent reinfestation was much slower on these thoroughly sprayed trees than on others where the toxicant was superficially applied to the outer branches and top of the trees.

4. DN-111, 1 1/4 pounds per 100 gallons of spray or 1/2 pound actual parathion (3422) per 100 gallons gave excellent control of mites without apparent injury to the foliage or fruit. Summer temperatures rose as high as 102° F.

5. In several orchards where only one or two applications of DDT-containing sprays were applied to apple trees of late varieties before the program was abandoned, up to 100 percent of the apples were wormy. This was a higher infestation level than in orchards receiving no spray applications.

6. Woolly apple aphis, spring and fall canker worms, and apple leafhoppers were of very minor importance this season.

OREGON

L. G. Gentner, Southern Oregon Branch Experiment Station, Medford.

Results of Investigation of Codling Moth and Associated Pests, 1948

The spring of 1948 was one of the coolest on record. Fruit set occurred about a month later than normal. The first codling moths were caught in bait pans on May 16. The first eggs were found on May 24 and these hatched on June 7. The first cover spray for the control of codling moth was applied about one month later than normal, during the first week in June. The cool weather also prolonged the period of emergence from hibernation quarters of the two-spotted mite and greatly retarded development during the early part of the season. The hatching of the winter eggs of the European red mite was delayed until the first week in May. Bartlett pear harvest began about September 1, or a month late.

Codling Moth Control

The use of DDT last season resulted in such excellent codling moth control, that further tests were deemed unnecessary; however, observations were made and some counts were made in the station pear orchard. Most of these trees received two applications of one pound of 50% DDT wettable powder, on June 7, 8, and on August 11, 12, except twelve Bartlett trees, which received only the first application. One-half percent of the fruit from the latter trees was wormy at harvest time, mostly recent entrances. Out of a total of 4,848 fruits examined from Bartlett trees receiving both DDT applications, only one fruit was wormy. Not one wormy fruit was found in 3,018 Comice fruits examined. The north half of two 23-tree rows of Comice trees, received four applications of 3 pounds of Kryocide and $\frac{1}{4}$ pound of Z-1 deposit builder, while the south half received two applications of one pound of 50% DDT wettable powder. At harvest time 7 percent of the fruit was wormy in the Kryocide plot, but none in the DDT plot. The growers of this area again obtained excellent control of codling moth with DDT. Two or three applications were made on Bartlett trees and three or four on late pears and apples. Dosages were from one to one and a half pounds of 50% wettable powder per hundred gallons, with the addition of $\frac{1}{4}$ pound of Z-1 deposit builder.

Spider Mite Control

The major effort in fruit pest control was directed against the two-spotted mite. This mite has become the foremost enemy of our fruit trees. Even before the general use of DDT, it had become very abundant in our orchards and had caused serious foliage injury.

The following materials were tested this past season at the station for spider mite control on pear trees: S-1104, containing 40% K-1875 (para para prime dichloro phenoxymethane), Dow Chemical Company; 15% parathion, Penphos W-15, Pennsylvania Salt Manufacturing Company; 25% parathion, Thiophos 25, American Cyanamid Company; IN-4200, alkyl-2-thiazolinyl lauryl sulfide, Du Pont Company; Dimite, 1,1-bis (p-chlorophenyl) ethanol (DMC), and hexaethyl tetraphosphate, Killex 50, Sherwin-Williams Company; L48, aryl alkyl sulfonate and 83N, mixed alkyl sulfite, Naugatuck Chemical Division, U. S. Rubber Company; DN-111, amino salt of dinitro-o-cyclohexylphenol, Dow Chemical Company; CR-1639, dinitrocaprylphenyl crotonate, Rohm & Haas Company; Toxaphene, chlorinated camphene, 50% water miscible, Hercules Powder Company; and Selocide, potassium-ammonium-seleno-sulfide, McLaughlin Gormley King Company.

The first ten of these were tested in a block of 25-year-old Anjou pear trees, smaller than normal, and growing on shallow soil which tended to lack sufficient moisture at times. This block annually was subject to heavy mite attack. Each plot consisted of six trees, and mite counts were made at weekly intervals until harvest time. The entire block received an application of one pound of 50% DDT wettable powder on June 7, at which time practically no mites were present. Mite sprays were applied with a Bean sprayer approximately a month apart, on July 16 and August 11, except in Plot 11, which received an extra application on August 2. One pound of 50% DDT was combined with the mite sprays in the last application for codling moth control. The average number of mites per leaf is given for each treatment in the accompanying table.

Only two of the four most promising materials in this test failed to injure fruit or foliage --- parathion and Dimite. The latter caused injury to 1½ percent of Comice fruit in another test, in the form of a faint russet ring on the inner side of the fruit.

Parathion at higher dosage was very effective. At dosages of ¼ to ½ pound of 15 percent material it was not satisfactory because of its shorter residual toxicity. For best results it should be used at the rate of 3/4 to one pound of 15%, or ½ pound of 25% parathion. Even at these dosages the deposit on the fruit is very low and disappears rapidly after application. Analyses showed only from .02 to .05 p.p.m. on the fruit at harvest time. Some orchards were checked where this material was used in the larger speed-type sprayers at the rate of 3/4 and one pound of 15% parathion in 100 gallons, 400 gallons per acre, or 3 or 4 pounds of material per acre. Very satisfactory control was obtained. No injury to fruit or foliage was noted where this material had been used.

Dimite, 1 pint per 100 gallons, gave outstanding control. The trees sprayed with this material carried the lowest mite populations of any of the plots, and at harvest time were quite free from mite damage. The slight injury to Comice fruits in another test indicates that it should be used with caution until further information is obtained.

Two-Spotted Mite Control on Pears

Plot and Materials Per 100 Gallons	Average Number of Mites Per Leaf							
	July 5	*July 22	July 27	Aug. 3**	Aug. 14	Aug. 21	Aug. 28	Sept. 4
#1 - 1½ lbs. S-1104 (K-1875), ¼ lb. Z-1	43.7	4.7	2.8	7.0	3.1	4.8	11.7	18.5
#2 - ¼ lb. 15% Parathion, ¼ lb. Z-1	43.7	1.5	5.6	3.2	2.2	9.9	6.6	14.0
#3 - ½ lb. 15% Parathion, ¼ lb. Z-1	43.7	1.9	3.8	2.3	2.4	10.3	19.2	12.0
#4 - 1 pt. IN-4200	43.7	2.0	0.6	4.6	0.6	5.1	9.4	3.3
#5 - 1 pt. Dimite	21.1	3.0	0.7	0.2	0.0	1.3	0.3	1.5
#6 - 3/4 lb. DN-111, ¼ lb. Z-1	21.1	19.0	13.4	19.6	40.0	59.4	60.3	105.0
#7 - 1½ lbs. L48 (aryl alkyl sulfonate)	21.1	12.0	11.2	13.2	12.0	16.1	15.0	13.2
#8 - 1 pt. 83N (mixed alkyl sulfite)	21.1	17.0	5.4	5.4	0.6	9.1	12.2	12.8
#9 - 1½ pts. CR 1639	21.1	3.9	1.9	6.3	1.4	1.2	0.6	1.8
#11 - ½ pt. Hexaethyl Tetraphosphate	21.1	17.1	9.8	3.8°	3.4	4.3	8.6	15.4
#12 - ½ lb. 25% Parathion ¼ lb. Z-1	21.1	2.7	0.5	2.5	0.7	2.7	2.2	4.7

Spray Applications - July 16*; August 2, Plot #11 only°; August 11, with DDT**

CR-1639 gave very good mite control, but caused injury to about one percent of Anjou fruits and two percent of Comice fruits in the form of a definite ring 3/4 inch or less in diameter on the inner side of the fruit, with darkened lenticels within. After harvest the foliage turned yellow and dropped before that on adjoining trees. This injury occurred when the material was used in the liquid form, but as a wettable powder, in another test, no injury occurred.

IN-4200 also gave good mite control, but toward harvest time a tan blotching made its appearance on most of the fruit. This intensified rapidly until at harvest time it had formed a dense, dark-tan russett. The blotches numbered from one to more than 25 per fruit and ranged from $\frac{1}{4}$ to 7/8 inch in diameter. They were irregular, somewhat angular, in outline.

S-1104 (K-1875) gave fairly good mite control, but toward harvest time caused a spotting of the fruit. The spots generally were quite circular in outline and varied from 1 to 20 per fruit. On Bartlett pears 60% of the fruit was affected, somewhat less on Anjou, and considerably less on Comice.

In another test Toxaphene in liquid form at 1 quart per 100 gallons gave good mite control, but caused a peculiar type of injury to 52% of Comice pears. This was in the form of an irregular russet ring from an inch to nearly two inches in diameter, on the inner side of the fruit. Some lenticels were also darkened.

Selocide was not received in time to be included in regular tests, however, it gave good mite control in a miscellaneous variety block, at $1\frac{1}{2}$ pints per 100 gallons, and no injury was noted.

Hexaethyl tetraphosphate has little residual toxicity, therefore requires closely timed applications to combat young emerging from eggs and re-infestations after spraying. Some lenticel injury occurred.

DN-111 at 3/4 pound per 100 gallons did not give satisfactory control the past season.

Tests were carried on with late dormant applications for the control of winter eggs of the European red mite. Four percent of a dormant oil in emulsion form or a combination of three percent of oil and three gallons of lime-sulphur gave excellent egg kill. A spray of two gallons of oil emulsion and three gallons of lime-sulphur permitted some eggs to hatch, but the mites subsequently disappeared. A spray of one percent of oil and three gallons of lime-sulphur failed to give satisfactory control. The higher dosages of parathion gave satisfactory control of summer forms.

Various stages of a tiny, black ladybird beetle, Stethorus picipes Casey were commonly found in the orchards of this area throughout the season, feeding on spider mites and eggs. Many adults were present at harvest time in orchards which had received two applications of DDT.

OREGON (Continued)

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Spraying Investigations - Newtown Apples 1948

Introduction

The principal objectives of the spraying investigations conducted at the Hood River Branch Station, involved practices built around the control of the codling moth, employing DDT as the insecticide used for this insect. Previous investigations covering a period of five years had demonstrated that a two-spray program of 1 pound of DDT to the hundred gallons of water was adequate in controlling this former primary apple pest. (See earlier reports.) The introduction of DDT has made it necessary to reinvestigate the entire spray program. The use of this material, although it has been completely successful in reducing the codling moth to minor status, has in turn, brought to the fore, as major pests, several species of mites, the woolly apple aphis, and other insect pests. This development has made it necessary to study not only the control of these insects by application of a number of new insecticides now becoming available, but to work out compatibility factors, not only involving the use of these materials, but employed with fungicides that would permit the control of apple scab and powdery mildew. Although much valuable information was gathered in 1948, there still remains much to be learned, particularly with reference to the economical and satisfactory control of the Willamette mite, which at the moment, constitutes the number one problem of the orchardists in the Hood River area.

The following materials were used at the Hood River Experiment Station in 1948:

Product	Company	Chemical Composition	Active
Deenate	DuPont	DDT	50%
DN-111	Dow Chemical Co.	Dinitro-ortho-cyclohexyl phenol	20%
Bladex	Shell Oil Co.	Hexaethyl tetraphosphate	50%
Parathion (3422)	American Cyanamid Co.	O,O-diethyl O-p-nitro-phenyl thiophosphate	25%
Gamtox	Calif. Spray Chem. Co.	Benzene Hexachloride	
IN-4200	DuPont	Lorol-2-thiazolinyl sulphide	75%
Dimite	Sherwin-Williams Co.	Di(p-chlorophenyl)methyl-carbinal	25%

Product	Company	Chemical Composition	Active
Arathane (CR 2639)	Rohm and Haas	Dinitro-capryl-phenyl crotonate	
Isotox	Calif. Spray Chem. Co.	Gamma isomer of Benzene hexachloride	25%
Extermoil	Apple Growers Assn.	Dormant oil emulsion	82%
Lime-sulfur	Apple Growers Assn.	Lime and sulfur	32°
Fermate	DuPont	Ferric dimethyl dithio-carbamate	

Codling Moth Control

Although a two-spray program of 1 pound actual DDT-100 gallons of water has been found adequate in controlling codling moth at Hood River, observations were continued for the purpose of determining compatibility with other sprays. This work will be continued with the use of fungicides applied for the purpose of controlling mildew and scab. The 1948 spray program and control obtained are shown in Table 1. A brief summary of results indicates the following:

1. None of the materials used in combination with DDT measurably affected the insecticidal values of this material.

2. Control (average wormy fruits) in the various plots ranged from .0 to .21. See Table 1. The plots were located in the same area used in 1947 during which year, the range of wormy apples in the various plots was .34 to 2.6 percent. There existed a substantial early moth population in this experimental area. (See blue line, moth catch record, Graph 1.)

3. Average percentage of stung apples ranged from .7 to 4.1. 69.9 percent of these "stings" could have been avoided by applying the first cover earlier. The first cover was purposely delayed for approximately one week after first worm entrance was noted. These newly entered worms were killed by the first DDT application. The injury caused by these newly hatched worms consisted of a healed, russetted area, approximately 1/8 inch in diameter. This type and amount of injury was of minor commercial importance. Stings of this character were more abundant in sections of the experimental area where control was poorest in 1947.

4. The purpose for delaying the first application was to permit the emergence of as many first brood moths as possible before applying the DDT, thus (1), destroying them by direct contact; (2) prolonging the effectiveness of the cover in the further destruction of emerging moths and their progeny; and (3) postponing favorable conditions for mite and woolly aphis build-up induced by the DDT application. To date, the values of this procedure have not been fully determined. It is evident that satisfactory codling moth control can be affected. This is the second season this practice has been followed at the Station in the general codling moth control program.

5. No evidence of spray injury occurred on fruit or foliage of Newtown apples as a result of the use of spray combinations shown in Table 1. DN-111 used with DDT resulted in some increase of sunburn on exposed apples in some of the tests. This increase, however, could be traced to timing and hot weather (above 93° or 94°) rather than effects resulting from the mixture.

6. Codling moth trap records have been maintained at the Hood River Station for the past 20 years. Ten traps, baited with dimalt and yeast, constitute the number of units employed in determining seasonal moth activity. During the years 1946 and 1947, approximately one-half of the Station apple orchard was sprayed with DDT. The other half received lead arsenate during this period. These orchard areas are separate units. In 1948, the entire apple orchard was sprayed with DDT. In 1947, where DDT was used, an average of .83 percent wormy apples resulted; lead arsenate, 19.0 percent wormy. Severe hail injury of fruit occurred in 1947. Lead arsenate failed to effectively stop worm entrance. This background is presented to indicate probable differences in numbers of 1948 carry-over worms in the two sections of the orchard.

Regardless of the fact that there has occurred a marked difference in worm carry-over during the past two years in these orchard blocks, moth catch prior to the first DDT application has been quite similar. This performance was contrary to that expected. In 1948, 81 percent as many moths were taken prior to the first DDT spray (June 9-12) in the area sprayed for three years with DDT than where lead arsenate had been used. In 1947, 72 percent as many moths were captured. After the first DDT spray in 1948, only 17 percent as many moths were taken where DDT had been employed for three years. From these observations, it would appear that extensive and general movement of moths occurs prior to the first DDT application where sources of re-infestation are present. This information leads to the conclusion that the use of bait traps may still be of value.

During the past three years where DDT has been used, moth catches, following the first cover have been quite similar. Moth take has been consistently low. The patterns of 1948 were quite similar to those obtained in 1946 and 1947. Where this three-year program had been employed, but 14 moths were taken after June 12 in the ten traps. Where DDT was applied for the first time in 1948, 83 moths were taken. Before the introduction of DDT, it was not uncommon to catch from 1000 to 2000 moths in ten traps during this period. It is concluded that the effective destruction of moths plays an important part in the worm control program. Attention to moth activity and the timing of sprays for their most effective destruction may account for the fact that a two-spray program results in the satisfactory control we have been able to obtain in the Hood River area.

TABLE 1 - SPRAY PROGRAM - 1948
CODLING MOTH & WOOLLY APHIS CONTROL
Hood River Branch Experiment Station

Note: Late Dormant, Extermoil emulsion 3¼ gallons-100 plus lime-sulfur 4 gallons-100 used in all tests unless otherwise indicated. DDT (50%) applied, 2 lbs.-100 in all covers unless otherwise stated. 25% Parathion used where this material was employed.

Exp. No.	Spray Program	Codling Moth - % Apples: Wormy	Stung	Clean	Woolly Aphis Infestation % (1) 8/30/48	10/12-16/48 Total	Abundant (2)
	Late Dormant 4/12						
1	1st Cover 6/9: Parathion ½-100 plus DDT	.0	2.2	97.7	.2	4.6	.7
	2nd Cover 7/28: Parathion 1-100 plus DDT						
Ck	No Late Dormant						
1	1st Cover 6/10: DDT 2-100	.05	.98	99.0	76.6	46.2	22.8
	2nd Cover 7/30: DDT 2-100						
	Late Dormant 4/12						
2	1st Cover 6/10: Gamtox 1-100 plus DDT	.06	.82	99.1	16.2	13.9	2.2
	2nd Cover 7/29: DN-111 ½-100 plus DDT						
2-a	Same as #2 plus						
	3rd Cover 9/4: Bladex only, 1 pt.-100	-	-	-	-	11.2	.4
	Late Dormant 4/12						
3	1st Cover 6/10: DDT only	.0	1.4	98.5	49.7	22.5	4.9
	2nd Cover 7/29: DDT plus DN-111 ½-100						
	No Late Dormant						
4	Early pink 4/21: Parathion only, 1-100						
	1st Cover 6/9: Parathion ½-100 plus DDT	.04	1.5	98.4	1.9 (3)	8.0	1.8
	2nd Cover 7/28: same as 1st Cover						
4-a	Program same as #4 plus						
	3rd Cover 9/4: Parathion only ½-100	.21	1.3	98.4	3.1 (3)	1.8	.0
	Late Dormant 4/12						
4-b	Early Pink same as #4						
	1st Cover 6/9: Parathion ½-100	.0	.7	99.3	2.2	6.7	.9
	2nd Cover 7/28: Same as 1st Cover						
	Late Dormant 4/12						
5	1st Cover 6/10: DDT only						
	2nd Cover 7/29: DDT plus Parathion ½-100 and Fermate 1½-100	.28	1.15	98.5	1.6 (4)	6.9	1.6

(This table continued on next page; see end of table for footnotes.)

(Table 1 Continued)

Exp. No.	Spray Program	Codling Moth - % Apples: Wormy	Stung	Clean	Woolly Aphis Infestation %(1) 8/30/48	10/12-16/48 Total	Abundant(2)
	No Late Dormant						
6	Early Pink 4/21: In 4200 1 pt.-100 no DDT						
	1st Cover 6/11: In 4200 1 pt.-100 plus DDT	.0	4.1	95.9	72.7	31.8	9.1
	2nd Cover 7/28: In 4200 ½ pt.-100 plus DDT						
	Late Dormant 4/13						
6-a	1st & 2nd Cover same as #6	-	-	-	58.2	4.0	.2
	3rd Cover 9/4: Isotox 1#-100, no DDT						
	Late Dormant 4/13						
7	1st Cover 6/12: DN-111, 3/4-100 plus DDT	.12	1.2	98.6	52.4	48.0	21.5
	2nd Cover 7/29: Same as 1st Cover						
	Late Dormant 4/13						
8	1st Cover 6/11: S.W.Dimite 1 pt.-100 plus DDT	.0	3.34	96.6	58.1	28.6(5)	7.3
	2nd Cover 7/29: Dimite 3/4-100 plus DDT						
Chk	No Late Dormant						
2	1st Cover 6/11: DDT	-	-	-	77.4	42.1	13.9
	2nd Cover 7/30: Same						
	Late Dormant 4/13						
9	1st Cover 6/14: DN-111 ½-100 plus DDT	.08	3.1	96.8	-	-	-
	2nd Cover 7/23: Same as 1st Cover						
	No Late Dormant						
10	1st Cover 6/11: DDT only						
	2nd Cover 7/28: Same	.05	1.3	98.6	71.2	39.7	14.8
	3rd Cover 9/4: CR 1639, No DDT						
	Late Dormant 4/19: Extermoil 3¼-100 plus						
W-1	Gamtox 1½-100						
	1st Cover 6/12: DN-111 ½-100 plus DDT	.17	3.7	96.1	11.8	16.1	3.8
	2nd Cover 7/23: Same as 1st Cover						
W-1	Late Dormant same as #9						
-d	1st Cover 6/10: DDT plus Gamtox 1-100	.0	3.6	96.4	1.2	.9	.0
	2nd Cover 7/29: DDT plus DN-111, ½-100						

(I) Population based upon insects occurring between nodes on sucker growth collected at random in the central portion of the trees. Each unit consisted of one bud and the space between it and the next bud. 800 to 2000 of these units were employed in each test. Number of trees examined ranged from 4 to 12.

(2) See explanation in discussion.

(3) Small colonies

(4) 50.8% infestation before applying 2nd Cover.

(5) Population erratic in various trees - perhaps error in application.

Woolly Aphis Control

Parathion and benzene hexachloride were found to be highly effective in the control of the woolly apple aphid. None of the other materials, used primarily for mite control, was found to be of value. These spray materials included DN-111, Bladex, IN-4200, Dimite, and Arathane. Control was based upon the aphis population occurring between nodes on sucker growth collected at random in the central portions of the trees. Each observational unit consisted of one bud and the space between it and the next bud. Eight hundred to 2000 of these units were employed in each examination. Samples were taken from 4 to 12 trees in each experiment. (See Table 1 for programs employed and control that followed.)

The most effective seasonal control resulted from the use of Gamtox, 1 1/2 pounds per 100 plus 3 1/4 gallons dormant oil per 100 applied April 19 as a late dormant and followed up in the first cover, June 10th, with Gamtox 1 pound per 100 plus DDT. Practically no woolly aphis developed on these trees throughout the season. See Experiment W-1-d. Whether or not Gamtox or other BHC sprays can be recommended for this purpose remains to be determined. Characteristic odor persisted for a long period in this plot. Fresh and canned fruit has been submitted to an official tasting team at Oregon State College for their opinion relative to possible deleterious effects. Samples from other plots have been submitted. A report on their findings is not available at this time.

Gamtox used with the dormant only, Experiment W-1, materially reduced the seasonal population. The degree of infestation was relatively light. Gamtox combined with oil-lime-sulfur in the late dormant resulted in severe injury. Thirty percent of the fruit buds were killed and other injured in varying degree.

Isotox, 1 pound per 100, a comparatively odorless benzene hexachloride applied as a third cover, September 4, cut down a severe infestation of 50.8 percent to 4.0 percent when the population was determined a month after spraying. The infestation on the internodes was light in character. (See Experiment 6-a, Table 1.)

Parathion was used at various dosages and number of applications. Excellent control was obtained in Experiment 1, where two sprays were applied; the first cover using 1/2 pound of 25 percent material and a second cover, July 28, employing 1 pound of the material. Two-tenths (.2) percent infestation was observed on August 30 and 4.5 percent, with only .7 percent recorded as abundant, on October 12. Parathion in four covers, Experiment 4-a produced the best results where this insecticide was employed. At the end of the season, but 1.8 percent infestations were found, all of which were light in character. Fermate, combined with parathion and DDT effectively reduced an extensive population when applied on July 29. Reasonably effective control prevailed through the remainder of the season. It is evident that there are now available two highly effective woolly aphis sprays. It remains to be determined how they can be most economically and effectively used for the control of this insect.

Continued use of DDT--two to three years in the Station orchard--has practically eliminated the woolly aphis parasite Aphelinus mali. Only six colonies of aphids were found attacked by this parasite while examining over 22,000 nodes and internodes on sucker growth. On the other hand, DDT does not appear to effect the activities of syrphid larva (species not determined). Examination of the data presented in Table 1 indicates that a lower aphis population occurred at the time of the October check-up than existed on August 30. This reduction was largely due to clean-up activities of syrphid larva.

Mite Control

There are three species of mites involved in the control problem in the Hood River area at this time. These are the Brown mite, Bryobia praetiosa, European red mite, Paratetranychus pilosus, and the Willamette mite, Tetranychus Willamettei. The control of the Willamette mite is by far the most serious problem. A rust mite is common on pears but no extensive control studies have been initiated to date.

Our mite studies are still in the exploratory stage. Some 20 different combinations were used in the 1948 studies where seasonal population records were taken. Two series of tests were run. One involved what we thought at the beginning of the season was a program for the control of European red mite. It developed later that we were dealing with a mixed population of European and Brown mite with a late infestation of Willamette mite. This block of trees had not been sprayed with a dormant spray for a number of years. An extensive egg deposit of the two species was present in the spring of 1948. Another series of tests was run in the Station orchard where the dominant species was the Willamette mite. This area had been regularly sprayed with a late dormant, oil-lime-sulfur spray for a number of years. The European--Brown mite complex was of minor proportions in the section of orchard annually sprayed.

Preliminary conclusions based upon studies conducted to date indicate the following:

European and Brown Mites

1. Dormant oil-lime-sulfur is an effective spray. Prior to DDT usage this one spray usually gave seasonal control. Where there occurs a later build-up, one or two parathion applications has produced excellent results.

2. Parathion applied in a pink and second cover used with Fermate for scab control effectively controlled these two species. The same materials used in a pink, first and second cover did likewise. DN-111 used with Fermate although quite effective early in the season, failed to produce sustained control. IN-4200 and Dimite produced good control as long as covers were maintained at intervals of a month to six weeks. Some build-up occurred late in the season when applications were discontinued. Dimite appeared to be somewhat

more effective than IN-4200. Early control, i.e. pink stage where no dormant spray had been applied, appears desirable.

3. Gamtox appears to exert little or no control on European and Brown mites.

4. Where the populations of the European red and Brown mites are dominant early in the season, activities of the Willamette mite are usually suppressed. Willamette mites eventually take over, late in the season.

5. Arathane, used late in the season in small tests only, appears to offer promise.

6. Based upon information now available, it is believed the European and Brown mites can be effectively controlled with a rather simple and economical program.

Willamette Mite

Generally speaking, the results obtained from the applications made in 1948 were disappointing. It appears that no simple and economical program can be devised from present known materials. The Willamette mite is apparently a more difficult organism to deal with than the Pacific, two-spotted, European red and Brown mite. Reasonably good control was obtained with several materials as long as coverage was maintained. However, as soon as these were discontinued, population build-up occurred. Further investigation of dosages and timing based upon information that is accumulating may result in the development of a practical solution of the problem. Matters of interest that appeared in the past season's work are as follows:

1. The late dormant, oil-lime-sulfur, effectively destroyed a very high percentage of overwintering mites. The mites were in the process of moving from hibernation quarters at the time the spray was applied. This spray practically eliminated infestation for a period of five or six weeks after which time build-up started.

2. Parathion failed to perform as it has for other investigators working on the control of Pacific mite. It was expected that two, and not more than three, applications would handle the problem. Further spraying should have been employed in a number of our tests. It appears that 1/2 pound per 100 dosage is insufficient for the Willamette mite. Better and more lasting control followed where an application of 1 pound per 100 was employed. Unfortunately, no complete program was conducted with this concentration. General control conditions and seasonal tree appearance was best where parathion was used at 1/2 per 100 in the first cover and 1 pound in the second cover. Control in this plot was better than where a pink of 1 per 100 was followed by three covers of 1/2 pound. A late damaging infestation likewise occurred where a pink spray of 1 per 100 was applied, followed by two covers of one half each. This performance is consistent with minor tests conducted in 1947.

3. Dimite very effectively controlled mites for a period of at least six weeks following each application. The late dormant oil-lime-sulfur followed by two covers (Plot 8, Table 1) reduced late build-up and appearance of the trees throughout the season indicated control was equal or better than most programs employed. Unfortunately, Dimite exerts little or no control of the woolly aphis.

4. IN-4200 appears to be somewhat less effective than Dimite with a shorter residual effect. Build-up occurred late in the season after spraying was discontinued.

5. DN-111 was found to be more effective where used at 3/4 pound per 100 than 1/2 pound per 100. The period of protection was found to be relatively short, indicating that three or four covers at least, would be necessary to prevent late season build-up. Need for care in applying this material was demonstrated. Increased sunburn occurred when the temperature reached 93° at the time of spraying or occurred for a few days following spraying.

6. Arathane, used in limited tests late in the season appears to be a promising material.

7. Hexaethyl sprays were not included in the 1948 program. Practical usage in 1948 demonstrated that these materials have, at times, a place in a seasonal program.

8. Mite damage was not measured in 1948 due to a very erratic crop performance in the Station orchard. Small sized fruits generally prevailed in the district. Seasonal growing conditions doubtless contributed to this development. There occurred but 93 clear days at Hood River in 1948. The severe hail storm of June 7, 1947, apparently effected the 1948 crop. Production in the hail area was generally poor being more pronounced in orchards where defoliation was excessive. The trees in some orchards lost a large proportion of their leaves with none uninjured.

Although foliage damage due to mite activity was quite noticeable late in the season, it is believed at this time that population arising after mid-September resulted in little commercial damage.

Parathion Deposits on Apples and Leaves and Losses Under Growing Conditions

In order to learn the rate at which parathion volatilizes or decomposes under growing conditions, samples of apples and leaves were taken at intervals immediately after spraying, for chemical analyses. The leaves from Newtown apples were sampled immediately after and following the application of the first parathion spray. Because the apples were so small at this time, samples were not taken until after the second parathion application. The results as given in the table indicate a rapid loss of the parathion. Apparently, also, the rate of loss from the leaves was much more rapid than

from apples, due probably to the relative waxiness of the surfaces. About 10 percent only of the parathion remained on the leaves after a week's period while on apples, approximately half still remained. The loss continued on the apples until harvest when less than .1 p.p.m. was present. Other substantiating data were obtained. All treatments show that if an interval of one month or more before harvest occurred following the last spray application, that a trace only of the parathion remained.

Table 2.--Parathion on Apples and Leaves

Spray Program	Character of Sample	Parathion Deposit	
		Apple P.P.M.	Leaves Mic./Sq. Cm.
1st Cover 6/10/48 Parathion 25% 1/2 lb.-100 DDT 1-100 (actual)	Before 2nd spray	.27	.03
	After 2nd spray	2.10	1.40
2nd Cover 7/28/48 Parathion 25% 1 lb.-100 DDT 1-100 (actual)	3 Days after 2nd spray	1.33	.27
	7 Days after 2nd spray	1.09	.18
	2 Weeks after 2nd spray	.80	.05
	3 Weeks after 2nd spray	.70	.04
	4 Weeks after 2nd spray	.30	.03
	2 1/2 Months (harvest)	.07	.02

UTAH

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1948 Spray Tests for the Control of Apple Insect Pests

The 1948 spray tests of the Utah Agricultural Experiment Station for the control of apple insect pests were conducted by the Departments of Entomology and Horticulture cooperating. They were performed at Logan in an old apple orchard situated on a rather steep side hill where the soil consists, in the main, of a shallow, coarse, gravelly loam. This orchard contains 394 old trees of several different varities.

In early spring the trees were found to carry extremely heavy populations of overwintering codling-moth larvae and eggs of the brown mite. Because of these infestations, this orchard was considered an excellent place in which to make comparative tests of certain insecticides to ascertain their relative effectiveness in controlling the infesting insect pests.

For initial control of mites, aphids, and mildew, the program specified in table 1 was executed.

Table 1. Experimental program executed during the delayed-dormant stage for the control of mites, aphids, and mildew, 1948

Insecticides used	Amount of insecticide per 100 gals. (gallons)	Stage of tree growth when applied	Portion of orchard treated
(1) Lime sulfur (liquid, 32-Baume')	12	early green-tip	½ of orchard
(2) Combination of lime sulfur (liquid, 32 B.) and dormant-type spray oil	3 1	early green-tip	¼ of orchard
(3) Dormant-type spray oil	6	early green-tip	¼ of orchard
(4) Lime sulfur	4	early pink-bud	½ of orchard

Treatments specified in table 1 were not replicated.

The experimental program carried out for the control of codling moth and summer infestations of mites and aphids is presented in table 2.

Table 2. Experimental program executed for the control of codling moth and summer infestations of mites and aphids (four replicates)

Sprays applied	Spray dates	Insecticides tested against			Amount of insecticide per 100 gals.
		Codling moth	Mites	Aphids	
Calyx	My. 28	(1) Lead arsenate	0	0	3 lbs.
1st cover	Je. 9	lead arsenate			3 lbs.
		plus	summer oil	0	2½ qts.
2nd cover	Je. 16	lead arsenate			3 lbs.
		plus	summer oil	0	2½ qts.
3rd cover	Jy. 13	lead arsenate			3 lbs.
		plus	light summer oil	0	6 qts.
4th cover	Jy. 23	lead arsenate			3 lbs.
		plus	summer oil		1½ qts.
			plus	nicotine sulfate	1 pt.
5th cover	Ag. 2	lead arsenate			3 lbs.
		plus	wettable sulfur		2 lbs.
			plus	nicotine sulfate	1 pt.
6th cover	Ag. 18	lead arsenate			3 lbs.
		plus	parathion (15%-W)		½ lb.
			plus	nicotine sulfate	1 pt.
7th cover	Ag. 31	lead arsenate			3 lbs.
		plus	parathion (15%-W)		½ lb.
			plus	nicotine sulfate	1 pt.
		(2) Cryolite (natural)*			
1st cover	My. 31	(3) DDT			2 lbs.
2nd cover	Je. 24	DDT			2 lbs.
		plus	parathion (15%-W)		¼ lb.
3rd cover	Jy. 14	DDT			2 lbs.
		plus	parathion (15%-W)		¼ lb.
4th cover	Jy. 28	DDT			2 lbs.
		plus	parathion (15%-W)		½ lb.
			plus	nicotine sulfate	1 pt.
5th cover	Ag. 6	DDT			2 lbs.
		plus	parathion (15%-W)		½ lb.
			plus	nicotine sulfate	1 pt.
6th cover	Ag. 23	DDT			2 lbs.
		plus	parathion (15%-W)		½ lb.
			plus	nicotine sulfate	1 pt.
		(4) Methoxychlor**			

* This insecticide was applied on the same dates, in the same amounts, and with the same materials and their amounts, for the control of mites and aphids as lead arsenate.

** This insecticide was applied on the same dates, in the same amounts, and with the same materials and their amounts, for the control of mites and aphids as with DDT.

Application of cover sprays was timed by moth catches in bait traps situated in five different locations of the orchard. Peak periods of moth flight, as indicated by moth capture in the bait traps, occurred during the last week in May, and from June 7 to 12. A third peak only two-thirds as high as the June maximum, occurred on August 18. Codling moths were continuously active all summer long with the exception of a couple of rainy days. A situation, unusual in Cache Valley, with reference to spring emergence of codling moth occurred in this orchard in 1948; codling moths became active, and were captured in bait traps before all of the blossom petals had fallen. Ordinarily the overwintered, or first-brood, moths do not become active until several days after the petal-fall stage.

Plots sprayed with DDT or methoxychlor did not receive a calyx spray. Colloidal spreader was also added to all cover sprays according to manufacturers' recommendations.

RESULTS OF TESTS

The delayed-dormant sprays gave satisfactory control of mites until about midseason, when moderate numbers of the brown mite appeared, necessitating repeated applications of miticides. Fifteen-percent parathion, at a dosage of $\frac{1}{4}$ pound per 100 gallons, failed to give satisfactory control of the brown mite or the woolly apple aphid. The latter built up to tremendous numbers even after $\frac{1}{2}$ pound of 15-percent parathion was used, beginning with the fourth cover spray.

One tree in the orchard was left unsprayed after midseason, to serve as a check or for comparison of the mite infestation with that on the sprayed trees. This tree became so heavily infested with brown mites that all leaves turned yellow, and practically all of the fruits had heavy rosettes of living mites and their eggs in the blossom ends. Throughout the orchard varying numbers of mites could be found after midseason, but on none of the trees were there sufficient numbers to cause any appreciable damage.

Although large numbers of dead woolly aphids were observed after each spraying with nicotine sulfate, nevertheless they multiplied so rapidly and produced such a heavy population that considerable damage was caused to young twig growth and much annoyance to pickers while harvesting the crop.

Data relative to results obtained with the various treatments for codling-moth control were taken near midseason (July 20 and 21) and more completely again during late September to mid-October while the crop was being harvested. During the latter period random samples of approximately one-fifth of the fruit from each of nearly all the trees were checked for worm infestation. The data taken at these two periods show the same order of superiority for the four different insecticides tested.

Methoxychlor gave the best control of codling moth of any of these insecticides. Statistical analysis of the data showed that the difference in the degree of control obtained with this insecticide was highly significant in comparison with that obtained with DDT.

DDT proved to be second best. Results obtained with it were significantly superior to those obtained with either lead arsenate or natural cryolite. Lead arsenate gave significantly better control than did natural cryolite.

A wind-driven hail shower occurred on July 4, causing much damage to tree foliage and breaking the skin of many of the apples, thereby opening an easy avenue of entry to injured fruit for codling-moth larvae. Many such entries were observed while inspecting the apples and taking other data in the orchard and this condition evidently was responsible for an increased infestation of apple worms.

VIRGINIA

W. S. Hough, Winchester Research Laboratory, Virginia Agricultural Experiment Station, Winchester.

Codling moth injury was at the lowest level noted in northern Virginia for many years due primarily to unfavorable weather conditions and to the general practice of using DDT. On the other hand, injury caused by the red-banded leaf roller mounted to a new high. No general outbreak of mites occurred, but late in the season the white mites, T. schoenei, threatened in a number of orchards.

The plum curculio, ordinarily not a serious pest on apples, caused considerably more damage than the codling moth in one experimental orchard where DDT was used exclusively throughout the season beginning with the petal-fall spray. Tests on plums indicate that parathion will control the plum curculio when used at the rate of 2 pounds of 25 per cent parathion per 100 gallons. It is believed that this may not be the minimum dosage required. But further tests will be necessary to establish the minimum dosage.

Tests against the first, second and third broods of the red-banded leaf roller confirm the results of 1947 to the effect that a single application of 25 per cent DDD (Rhothane) properly timed controlled this insect. Results of a single spray on July 21, 1948 against second brood red-banded leaf roller larvae were as follows:

Materials and Amount Per 100 Gallons	Per Cent Control*
25% parathion 1 lb.	98
25% parathion 2 lb.	99
25% Rhothane 1 qt.	97
50% Rhothane powder 2 lb.	100
25% Rhothane 1 qt. and Bordeaux 2-4-100	99
15% parathion (Aphamite) 3 lb.	100
15% parathion (Aphamite) 3 lb. & Fermate 1 lb.	100
40% chlorinated camphene (Chlorpheen) 2½ lb.	92

*Control based on comparison of live larvae found just before spraying and 3 days later.

Results of a single spray applied against third brood larvae on September 13, 1948 (when many of the larvae were webbed between two leaves and therefore not exposed to direct contact with the spray) were as follows:

Materials and Amount Per 100 Gallons	Per Cent Control
25% parathion ½ lb.	59
25% parathion 1 lb.	80
50% Rhothane powder 1 lb.	94
50% Rhothane powder 1½ lb.	85
Marlate 3 lb.	42
25% parathion 1 lb. & 40% sulfur paste 5 lb.	72
50% Rhothane powder 1 lb. & 40% sulfur paste 5 lb.	78

In another orchard where most of the third brood larvae were on water sprouts or on single leaves and therefore more subject to contact with the spray, results of tests applied on September 8, 1948 were as follows:

Materials and Amount Per 100 Gallons	Per Cent Control
50% Rhothane powder 1 lb.	91
50% Rhothane powder 1 lb. & 70% sulfur paste 6 lb.	62

Effect of various spray combinations on the control of codling moth and red-banded leaf roller in an experimental orchard of York Imperial trees is summarized in the accompanying table. Codling moth injury includes all drop fruits as well as harvested fruits, but the record of leaf roller injury is based largely on the examination of the harvested fruits in September.

Plot	Amount in 100 Gallons	Fruit Injured: Codling Moth %	Fruit Injured: Leaf Roller %
Cather Orchard (Lead 3 lb., lime 6 lb., and lime-sulfur 6 qt. in petal-fall (week of April 26) and 1st cover spray (week of May 10) applied by grower.) The materials, except as noted, listed below were applied in the 2nd to 5th covers (May 21, June 4, June 19, and July 28, respectively). Fungicide 341-C1/ 1 qt. plus lime ½ lb. was added in 4th and 5th covers.			
1.	50% Methoxychlor 2 lb.	6.69	44.88
2.	25% Gytol2/ 2 lb.	10.51	32.80
3.	Ryania (ground root) 6 lb.	1.21	50.81
4.	25% Thiophos 3 lb.	0.70	3.54
5.	Lead arsenate 3 lb.	5.90	0.69
6.	50% DDT 2 lb.	0.69	22.91
7.	50% DDT 2 lb.; Neotran 1¼ lb.	1.27	16.96
8.	50% DDT 2 lb.; Neotran 2½ lb.	4.13	14.70
9.	50% DDT 2 lb.; (IN-4200 1 pt. in 2nd cover)	1.35	44.70
10.	50% DDT 2 lb.; 25% Thiophos ¼ lb.	1.62	34.31
11.	50% DDT 2 lb.; 25% Thiophos ½ lb.	0.88	19.84
12.	50% DDT 2 lb.; 25% Thiophos 1 lb.	0.00	6.29
13.	50% DDT 2 lb.; 25% Aryl Alkyl Sulfonate 1 lb.	0.80	34.17
14.	50% DDT 2 lb.; (Miticide #63/ ½ gal. in 2nd cover)	0.89	34.78
15.	50% DDT 2 lb.; 25% Mixed Alkyl Sulfite ½ pt.	0.19	24.97
16.	50% DDT 2 lb.; DN-111 1¼ lb.	0.48	37.16
17.	Rotenone 1%4/ 8 lb.	39.00	19.82
18.	50% DDT 2 lb.; Neotran 2½ lb.	3.29	27.47
19.	50% DDT 2 lb.; Dimite5/ 1 pt.	1.15	27.63
20.	50% DDT 2 lb.; 25% Thiophos ½ lb.	0.51	7.54
Check, not sprayed		35.47	16.01

1/ 2-heptadecyl glyoxalidine.
2/ Contains 25% ditolyl trichloroethane.
3/ Polyalkylene glycol derivative.
4/ T-280 powder containing 1% rotenone and 4% piperonyl cyclonene.
5/ 25% Di (parachlorophenyl) methyl carbinol.

25% Thiophos is 25% parathion.

CANADA (British Columbia)

J. Marshall, Dominion Entomological Laboratory, Summerland.

Summary of Experimental Results in Codling Moth and European Red Mite Control - 1948

Codling Moth - The last three years have been unfavourable for codling moth development. In British Columbia DDT is now generally used for codling moth control. Codling moth populations have dropped to trace proportions in many orchards. An example was the experimental orchard in which, on unsprayed check trees, there was 1 entry per 1500 apples. A few years ago this orchard was receiving 6 cover sprays annually and some years infestation reached 20 per cent. No infestation records were obtained this year.

European Red Mite - Fifteen % parathion 8 oz.:100 gal. (Imperial measure) or potassium ammonium selenosulphide preparation ("Selocide") 1 qt.:100 gal. applied to apple at the pink stage, were more effective than a dormant application of dormant oil (220 S.S.U. Vis. 100°F.) 2 gal.-lime sulphur 4 gal.:100 gal. These pink-sprayed plots required no summer mite sprays.

As a summer spray, parathion 15% 0.5 lb.:100 gal. used in 3 applications together with DDT was approximately as effective as monoethanolamine dinitrocyclohexylphenolate 2 oz. (parent compound) used with DDT. But at the end of the season, trees that received parathion-DDT carried twenty times as many winter eggs as did those that received the DNCHP salt with DDT and sixteen times as many as those that received no sprays of any kind. On the other hand, the latter compound, when used in concentrate sprayers, has been more prone to result in foliage injury than parathion. Incidentally, the D.N.C.H.P. salt was used almost exclusively by growers for red mite control in British Columbia during 1948 and except in a few cases, gave satisfactory results at low cost. Diparachlorophenyl methyl carbinol 25% powder 1 lb.:100 gal. in 3 cover sprays with DDT was inferior to parathion 15% 0.5 lb. but resulted in far fewer winter eggs. Lauryl,2-thiazolinyl sulphide 75% ("IN-4200") 1 pint:100 gal. was somewhat more effective than Parathion 15% 0.5 lb. and also resulted in far fewer winter eggs. At that concentration, however, it caused considerable foliage injury to apple. Di(4-chlorophenoxy) methane 40% ("Neotran") 1.25 lb.:100 gal. was approximately as effective as DMC but caused distinct russet spotting of Delicious fruits. Tetraethylpyrophosphate 40% 0.5 pt.:100 gal., gave excellent immediate kill of European red mite but its residual action was poor and it caused foliage injury of apple and serious foliage and fruit injury of pear. Monoethanolamine dinitro-o-secondary butyl phenolate 2 oz. (parent compound):100 gal., gave excellent summer control of red mite but caused serious fruit and foliage injury of apple. Addition

of polyethylene polysulphide 0.5 lb.:100 gal. to parathion and DMC did not prove encouraging. Purpose of the mixture was to produce a very adhesive residue. Two liquid concentrates of parathion, one from a U.S. manufacturer, the other from a Canadian manufacturer, caused considerable foliage and fruit injury to apple when used at equivalent concentration to 0.5 lb. of 15% parathion powder in concentrate spray equipment. The powder caused no injury. Perhaps the most interesting feature of the fairly extensive acaricidal trials was the great impetus given to winter-egg laying by parathion 15% 0.5 lb. plus DDT 50% 0.5 lb.: 100 gal. The same material at 2 lb. but lacking DDT did not produce that effect.

High-Speed Concentrate Sprayers

Work was continued for the third year with high-speed concentrate sprayers in experiments designed to eliminate hand spraying. Basis of the work was operation of the Okanagan Experimental Sprayer, a machine designed in the Okanagan Valley and built by the Defence Research Station at Suffield, Alta. Apple scab control was not quite as good with the Okanagan Experimental Sprayer (both steam and hydraulic units) as with hand spraying, but the machine was operated at twice the intended speed and used much less spray material than hand application. The steam and hydraulic units of the same machine controlled mildew on apples to about the same extent as hand spraying. A commercial concentrate trailer-blower was evidently as effective as hand spraying for San Jose' scale control in the dormant period. Three concentrate machines (two of them commercial adaptations of the Okanagan Experimental Sprayer) gave almost as good control of pear psylla as did very thorough and heavy hand spraying. These machines were also as effective as hand spraying for summer control of codling moth and European red mite. Chemical analyses of oil deposits revealed that both the trailer-blower and Okanagan Experimental Sprayer applied sprays very uniformly in the dormant period. pray deposits in the tree tops were almost as heavy as deposits on the lower branches, while with hand spraying the deposits at the tops were often lower than deposits at the bottoms. Average deposits with concentrate machines were higher than those from hand spraying although dosages per acre were similar. Concentrate machines did not give as uniform deposits as hand spraying on large apple trees in full foliage. Indications are that high-speed "automatic" sprayers probably cannot be made to do as good a job of pest control as thorough hand spraying (up to 1500 Imperial gal. per acre), but will probably do a better job than the average man with a hand gun and at the same time effect a saving in labor costs of up to 90%.

CANADA (Continued)

T. Armstrong, W. G. Garlick, Dominion Entomological Laboratory, Vineland Station, Ontario, and J. A. Hall, Dominion Fruit Insects Laboratory, Simcoe, Ontario.

In 1948 the first half of the season was such that emergence of moths from overwintering larvae was delayed and protracted and early cover sprays were therefore relatively unimportant. The third week in August was exceptionally hot, the daily means running over 80° F. which, occurring well after all cover sprays were applied, brought about considerable injury in a number of orchards. In general it may be said that codling moth increased slightly over the previous year.

European red mite infestations were quite spotty and on the whole were not serious. DDT sprayed orchards usually carried a higher population but there were exceptions. In three widely separated orchards the two-spotted mite was the predominating species, in all others observed red mite constituted over 90 percent of the mite population.

Red banded leaf roller increased generally but with a few exceptions caused less than 1 or 2 percent injury to fruit.

Results of Control Experiments

Four cover sprays of DDT or five covers consisting of DDT alternated with lead arsenate-oil gave markedly better control on apples than lead arsenate alone but failed to give commercial control where adjacent orchards were unsprayed or poorly sprayed. In a semi-isolated orchard five covers of DDT applied two years in succession have reduced deep injury to one percent. Parathion, 2 pounds of 25 percent per 100 Imperial gallons in four cover sprays compared fairly well with DDT but caused some injury to fruit and foliage at the first cover (mild sulfur fungicide used).

Parathion injury to foliage consisted in a burning of areas of the leaves and in some cases the whole leaf. Affected leaves soon dropped leaving the trees normal in appearance as viewed from a distance. Fruit injury did not show up till quite late in the season though obviously brought about earlier. It first appeared as evenly spaced dark dots about pinprick size. These dots increased in size with the fruit growth and finally were large enough to be very conspicuous. The injury, though superficial, degraded the fruit and up to 30 percent was affected seriously.

So soon as the foliage injury occurred a test was undertaken on large McIntosh trees (2 trees per test) using parathion 25 percent, 2 pounds, per 100 Imperial gallons, (a) alone, (b) with a mild sulfur), (c) with Fermate, (d) with COCS and lime. No foliage injury showed up in any of the plots so treated which would further indicate that injury was produced only at the first cover.

On pears two covers of DDT gave better control than either parathion or lead arsenate with summer oil.

In the Simcoe area the results from grower spraying in commercial orchards in general were that full programs of DDT gave satisfactory control of codling moth but led to a marked build-up of red banded leaf roller and of red mite to the extent that a miticide was required in two cover sprays. The use of an alternation of DDT and lead arsenate or the use of a combination of the two in four cover sprays gave good control of codling moth and red banded leaf roller but favoured red mite. In one large orchard alternation of DDT and lead arsenate-summer oil gave excellent control of codling moth, red banded leaf roller and red mite.

Control of European Red Mite

Plots consisting of eight large Delicious trees, duplicated, were given five covers of DDT (2 pounds of 50 percent) at ten day intervals and the following acaricides added to the third and fourth covers. Rates given are for 100 Imperial gallons.

1. Monoethanolamine salt of DNOCHP (4 oz. DNOCHP)
2. Monoethanolamine salt of DNOCHP (2 oz. DNOCHP)
3. Check
4. DN-Dry Mix No. 1, 5 oz. (2 oz. DNOCHP)
5. DN-Dry Mix No. 1, 5 oz., Neotran 1 1/4 lb.
6. DN-Dry Mix No. 1, 2 1/2 oz., Neotran 3/4 lb.
7. Neotran 2 1/2 lb.
8. Parathion 15%, 2 lb.
9. Parathion 15%, 1/2 lb.
10. IN-4200, 1 pint.

The check (plot 3) became quite heavily infested with mites. All other plots showed satisfactory mite control and uninjured foliage. Judged by mite counts the parathion plots 8 and 9 were outstanding and showed no tendency to a build-up late in the season. Some foliage burn, unsightly but not serious, appeared in plot one and a trace in plot 2. There was a trace of leaf burn in plot 10 but this may not have been produced by the IN-4200.

Parathion 15 percent at 4 ounces per 100 Imperial gallons gave 99 percent mortality of red mite when thoroughly applied to two large heavily infested Yellow Transparent trees. Small scale experiments indicated that though very low concentrations gave good immediate kills there was very little residual action. Residual action increased with increase of concentration. In the plot tests above, plot 8 was definitely better (by mite count) than plot 9, though the latter was better than all other treatments.

AUSTRALIA

R. M. Stephens, Biological Branch.

DDT Trials in the Goulburn Valley

A further season of experiment and observation on the control of codling moth with DDT has conclusively demonstrated the phenomenal effectiveness of this insecticide.

The use of DDT by growers, involving the treatment of large areas, has shown that three sprays in one season can reduce the infestation level to less than one percent. Observations indicate that it may be possible to maintain this low level of infestation with even fewer sprays.

In so far as this district is concerned there have not yet been any serious complications due to mite infestation. Bryobia Mite (Bryobia practiosa Koch) has been adequately controlled by a thorough dormant red-oil spray. In an emergency, however, summer spraying with HETP (Hexaethyl tetraphosphate) can be expected to give control for both Bryobia and Red Spider (Tetranychus urticae Koch).

It has been noted that where the use of lead arsenate has been completely abandoned and where no DDT has been applied in the midseason period, there has been an increase in the population of Light-brown Apple Moth (Tortrix postvittana Walk.). One spray of lead arsenate at the usually recommended strength in midsummer should be all that is required to control this pest.

Further replicated tests of DDT in three pear orchards during the 1947-48 growing season showed that efficient control of codling moth can be obtained with a schedule of three sprays of DDT at a concentration of 0.1 percent DDT. This program was significantly superior to either two sprays of 0.1 percent or three sprays of 0.05 percent under the same conditions. It was also demonstrated that the optimum time for the application of the first spray was in the eight days following the first major peak of emergence. In one test chlorotic mottling was very definite adding support to the contention that oil even in small quantities should not be included in a DDT program.

AUSTRALIA (Continued)

G. T. O'Loughlin, Biological Branch.

DDT Trials for Codling Moth Control in Southern Victoria

Summary:

DDT trials for codling moth (Cydia pomonella L.) control on Jonathan apples were carried out on two orchards in the metropolitan area during the 1947-48 season. During the previous (1946-47) season one of these orchards was sprayed with DDT for codling moth control, the other with lead arsenate only. The amounts of DDT (dispersible powder) applied in the trial varied from two sprays of 0.05 percent (half standard strength) DDT to five of 0.1 percent DDT. A calyx spray was included in some treatments. Information was also obtained on the use of DDT for control of the light brown apple moth (Tortrix postvittana Walk.). The results are summarized below:

Codling Moth

1. The inclusion of a calyx spray resulted in no significant improvement in control.

2. Two cover sprays of half standard strength DDT (0.05 percent) gave good control where DDT had been used previously.

3. Better control was obtained where a DDT program had been used the previous season.

Light Brown Apple Moth

1. The inclusion of a calyx spray gave significantly better control of the light brown apple moth.

2. Light brown apple moth damage became progressively greater as the amount of DDT applied was reduced.

3. Damage was considerably greater on the orchard which received DDT the previous season.

AUSTRALIA (Continued)

Queensland.

Codling Moth Control Experiment, 1947-48

The experimental work on codling moth control in apples followed logically from the results obtained in 1946-47 and was mainly concerned to determine:- (a) The necessity for a calyx spray application; (b) The practicability of controlling red mite and woolly aphids in orchards subjected to DDT sprays; and (c) The comparative merits of DDT sprays prepared from dispersible powder and emulsion concentrates.

The experiment was located at Applethorpe and comprised five randomised blocks each containing nine single tree plots. The trees were all of the Granny Smith variety and were selected for uniformity in size and vigour.

Seven sprays were applied between October 27th and February 17th. The early sprays were timed from data collected in codling moth lure traps scattered throughout the district as well as in the experimental orchard. The late cover sprays were applied at approximately three week intervals because the lure traps failed to catch representative moth populations in DDT sprayed orchards during late summer.

The trees flowered in mid-October and the fruit set was normal. Some shedding occurred later on and the final crop harvested was light to medium, average trees carrying approximately 2 1/2 bushels of large well-formed fruit. The main pest, codling moth, was very active in the early part of the season. Woolly aphid and red mite, though more numerous than would normally be the case in the absence of DDT seldom became really troublesome.

Conclusions to be drawn from the work are:

(1) The lead arsenate - zinc sulphate - hydrated lime spray caused very little spray burn in the treated trees and appeared to give reasonably effective control of codling moth.

(2) DDT sprays prepared from dispersible powders and emulsion concentrates both gave very good control of codling moth but the emulsion sprays were the more effective. Spray concentrations of 0.1 percent DDT appear to be adequate for orchard use.

(3) The scarcity of moths in the orchard during the latter part of the season suggests that fewer sprays may give commercial control of codling moth. Possibly four or five sprays would be adequate. Whether or no the first of these should be a calyx spray has yet to be determined but it seems clear that the omission of a calyx spray need not have disastrous consequences if the first and subsequent cover sprays contain DDT.

(4) The woolly aphid parasite was active on DDT sprayed trees throughout the season and woolly aphid was not a major pest. It is probable that the dispersible powder sprays permit a larger amount of parasite activity than is the case when emulsion sprays are used.

(5) Dormant lime-sulphur followed by DDT calyx and cover sprays gave better control of red mite throughout the season than schedules in which the dormant spray was replaced by wettable sulphur or Hexone as a supplement to DDT in alternative cover sprays.

The main experiment was supplemented by exploratory trials with zinc fluoarsenate and Dynone. The zinc fluoarsenate caused some foliage burn but control of codling moth equalled that given by lead arsenate - zinc sulphate - hydrated lime spray. The Dynone showed considerable promise as an acaricide when used at a concentration of 1 in 300 with the DDT sprays.

AUSTRALIA (Continued)

N. C. Lloyd, Orange District.

Codling Moth (Cydia pomonella) Experiment at Bathurst and Orange, 1947-48

Introduction:

In the season 1947-48, further research was conducted on the control of codling moth by the use of DDT sprays. In previous work DDT at 0.1 percent was used throughout the entire spraying season.

Last season, modifications of this programme were tested. These included omitting the calyx spray, discontinuing the use of DDT after the third cover spray in late December, and reducing the concentration of DDT from 0.1 percent to 0.05 percent.

In addition, a comparative test was made of the efficiency of DDT in the dispersible powder form, and in the mayonnaise emulsion form.

The general aim of the season's work was to evolve a programme of DDT spraying which would eliminate any danger to bees at or about the "calyx" period, to lessen the cost of control by a reduction in the number and concentration of DDT applications, and, by discontinuing DDT sprays in December, to avoid an undue build-up of mite population during January and interference with the activity of the valuable woolly aphis parasite, Aphelinus mali.

Unfortunately, an exceptionally cool and rainy season, which was extremely unfavourable to moth development, rendered the experiments far less valuable than they might otherwise have been. No very definite conclusions could be drawn from the results obtained. Both in the Bathurst and Orange districts damage by codling moth was quite negligible.

Summary.

1. The season was very unfavourable to codling moth and infestation was negligible in the Bathurst and Orange districts.

2. This means that results cannot be regarded as conclusive, or as an indication of what might happen in a more normal season.

3. At Bathurst there were indications that discontinuing the use of DDT in the dispersible powder form after the third cover spray led to slightly increased infestation.

4. The emulsion form of DDT gave slightly superior control to the dispersible powder form when used in four sprays up to the third cover spray and also when used right through the season.

5. Postponing the initial spray from the "calyx" until a few days after petal fall did not lead to any increase in infestation.

6. DDT emulsion 0.05 percent appeared to be as effective as 0.1 percent emulsion.

7. DDT in the dispersible powder form is compatible with summer strength lime sulphur.

8. At Huntley, there did not appear to be any significant difference between treatments, i.e., 0.05 percent powder as effective as 0.1 percent powder leaving off DDT in late December did not lead to any additional infestation and delaying initial spray until all petals had fallen also did not lead to increased infestation.

9. Red mite (Bryobia) and red spider (Tetranychus) did not develop as pests.

10. Woolly aphis was very prevalent due to very favourable climatic conditions, which were unfavourable to the Aphelinus parasite.

11. DDT seriously interfered with the activity of Aphelinus.

12. DDT however tended to limit woolly aphis infestation during the time it was being applied, so that DDT trees were not as severely damaged as trees sprayed with lead arsenate.

13. Where there is an outside source of Aphelinus, activity by it will commence in trees some five weeks after spraying with DDT has been discontinued.

AUSTRALIA (Continued)

E. J. Wason, Murrumbidgee Irrigation Area, New South Wales.

The following programs were tested on two-tree plots in a randomized set-up replicated five times with the exception that the untreated checks were replicated three times.

A. Standard lead arsenate-white oil programme, viz., lead arsenate 3 pounds plus 1 gallon of a white oil emulsion to every 100 gallons in the second, third and fourth cover sprays. In the calyx and remaining cover sprays white oil emulsion at the rate of 1 quart to every 100 gallons of lead arsenate spray was added as a wetter, spreader and sticker.

B. Identical with A. except that in the second, third and fourth cover sprays DDT (water dispersible powder) at a concentration of 0.05 percent was added to the lead arsenate in lieu of white oil 1:100.

C. DDT (Australian water dispersible powder) at a concentration of 0.1 percent throughout the season.

D. DDT (American water dispersible powder) at a concentration of 0.1 percent throughout the season.

E. DDT (water dispersible powder) at a concentration of 0.1 percent in the calyx and first four cover sprays, followed by lead arsenate 3 pounds plus 1 quart of a white oil emulsion to every 100 gallons in the remaining cover sprays.

F. Untreated checks.

A calyx and seven cover sprays were applied from October 23, 1947 to February 21, 1948. A pre-calyx examination showed a light infestation of the woolly apple aphid and that the parasite Aphelinus mali was present and fairly active. DDT has not been used on these trees in past seasons. A dormant oil spray, 1:25, was applied during July 1947 for control of San Jose scale, woolly apple aphid and red mite, Bryobia praetiosa. The infestation of the latter was very light.

Fruit from the red varieties, three trees, was harvested February 24, 1948 and that from the remaining trees, Granny Smith variety, April 7, 1948.

Comments:

1. The degree of infestation in the case of the untreated check trees varied from 89.3 percent to 38.5 percent, averaging 66.2 percent.

2. While good control of codling moth was obtained with all treatments when compared with the untreated check trees, the percentage of stung fruit in the case of treatment A. is high, when compared with other treatments.

3. Comparable results were obtained with the Australian and American water dispersible powders at a concentration of 0.1 percent. Compare treatments C and D.

4. The use of DDT at a concentration of 0.05 percent in combination with lead arsenate in the second, third and fourth cover sprays in lieu of white oil at a concentration of 1:100, resulted in only slightly better control. However, the percentage of stung fruit was noticeably reduced. Compare treatment A with treatment B.

5. The use of DDT in the calyx and first four cover sprays for the control of the over-wintering or spring brood, followed by lead arsenate in the remaining cover sprays, gave nearly as good control as where DDT was used right throughout the season. Compare treatment E and treatments C and D.

6. San Jose Scale: While examining and counting harvested fruit a close watch was kept for the presence of this species of scale. No trace of scale was found on the fruit from the straight DDT treatments C and D, whereas in the case of treatment A infested fruit was found on seven of the ten trees, up to 12 fruits on one tree being found infested. In the case of treatments B and E, very lightly infested fruit was found on two and three trees respectively, while on the untreated check trees infested fruit was found on four out of the six trees included in the experiment.

Conclusions:

The results of this season's work confirm the results obtained during the previous two seasons, i.e., that DDT is a most effective insecticide for the control of codling moth but that its use causes an increase during the growing period in the population of other economic insect pests of pome fruits, viz, (1) woolly apple aphid and (2) Tetranychids, both red mite and red spider, especially the latter in the Murrumbidgee Irrigation Area.

Even the use of DDT at a concentration of 0.05 percent in three cover sprays caused a build-up of the woolly aphid population to such an extent that control measures had to be adopted during the late summer and early autumn. It appears that this build-up is due mainly to the effect of DDT on the parasite Aphelinus mali, causing a high mortality of same. From observations made it can be said that even one spray of DDT reduces the population of this parasite to a noticeable extent and at the same time that DDT, as a water dispersible powder, exerts little or no control of this aphid throughout the season.

During the past three seasons red spider has become a major pest on DDT sprayed trees, first showing up about mid-December of each year, and from then on rapidly assuming pest proportions, rendering control measures necessary. While red mite activity is also stimulated by DDT, it has not been of such consequence as red spider during the past three seasons. It appears that this species of mite favours mild moist conditions for its development as it soon disappears with the advent of hot and dry conditions which are typical of the summer months in the Murrumbidgee Irrigation Area.

Finally, it can be said that the standard programme of lead arsenate-white oil, as recommended by the Department of Agriculture, can still be relied upon to give good control of codling moth provided such is applied thoroughly and at the correct time.

Spring-Brood Codling Moth Control Test, 1947/48

The main objective of this test was to ascertain whether it was possible to obtain effective control of codling moth for the entire season by the use of DDT, at a concentration of 0.1 percent, while the emergence of the spring brood of moths was taking place. Needless to say, it was necessary to obtain an isolated block of pome fruit--apples, in this instance--so that the possibility of adult moths migrating to the block from adjoining farms was reduced to a minimum.

This experiment was carried out on a block of 304 apple trees made up of 284 of the Granny Smith variety and 20 trees of the Delicious variety. The closest planting of pome fruit was at least one mile from this block located in a north to northwest position.

The trees included in this large scale test, which were planted in 1937, were cut back heavily during both 1946 and 1947 in order to encourage growth of new wood. Further, the spur growth was cut back hard. This severe pruning would account to a large extent for the light crop which eventuated for this season.

The DDT used in this experiment was a water dispersible powder containing 50 percent p.p.i. DDT. The various sprays were applied with a power spray fitted with rods at a pressure of 250-300 pounds per square inch.

The calyx spray was applied October 22 and 27, 1947 and the cover sprays were applied November 5, November 18, December 3 and December 24, 1947. Hexaethyl tetraphosphate, 1/2 pint/100 gallons, was applied March 3, 1948 for the control of the red mite, Bryobia praetiosa. Harvest began March 25 and was finished April 2, 1948.

Results on harvest fruit were as follows:

Totals	Sound Fruit	Infested Fruit
Number	33,010	98 (all side entries)
Percentage	99.704	0.296

Results on the total crop, harvested fruits and drops were as follows:

	Sound	Infested	Stings
Numbers	38,590	518	61
Percentage	98.52	1.3	0.18

General Observations:

No trace of the woolly apple aphid was recorded in the experimental block and red spider, Eotetranychus telarius, at no time became plentiful enough to cause injury. The red mite, B. praetiosa was first observed December 10, 1947 and built up rapidly until mid-January 1948 after which time, with the advent of hot, dry weather, the population diminished gradually. Odd fruits were found lightly infested with San Jose scale while the harvested fruit was being sorted and graded. A dormant oil spray had not been applied for four or five years.

Conclusion:

From the above figures it can be seen that excellent results for the whole season was obtained by the use of DDT for the control of the spring or overwintering brood of codling moth.

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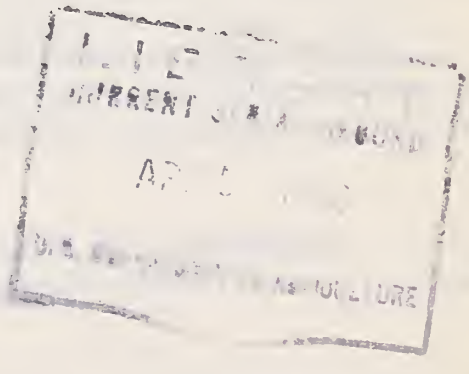
March 21, 1949

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1948

Part I (Supplement)

Work Conducted by State Agencies,
Entomological Branch, Canadian Department of
Agriculture and Commonwealth of Australia



Not for Publication

CANADA

H. T. Stultz, Dominion Entomological Laboratory, Annapolis Royal, N. S.

I. Seasonal Conditions and Codling Moth Abundance During the 1948 Season

Although emergence and egg laying were delayed by cool weather in the early part of the season, through July and August the codling moth was very active.

In general the orchards were more heavily damaged and the infestation more widespread than ever before in the history of the Annapolis Valley.

During the past ten years orchards with moderate to heavy infestations of the codling moth have become common in almost all districts in the apple growing area. Ten years ago it was present in these areas but was practically unknown to the growers since it constituted no economic problem.

Whereas ten years ago no special control measures were necessary, in 1948 a few growers used DDT and many of them used cover sprays of lead arsenate. The partial failure of the latter material will probably lead to fairly widespread use of DDT in 1949.

Since codling moth has been present for a long time its sudden rise during the past ten years appears to be related to the spray program which may be destroying the natural enemies of the codling moth.

II. Prevalence of the Parasite Ascogaster quadridentata The Time Factor and Prevalence

A. quadridentata continues to be the only parasite which gives any substantial degree of control of the codling moth in Nova Scotia. The highest percentages of parasitism by this Braconid have been observed in a few orchards which had not been sprayed for several years but in which the codling moth had been established for many years. The variations from year to year in these orchards was from 24 to 75 percent parasitism. In one case where a commercially sprayed orchard received only bordeaux with no insecticides in 1947 the parasitism was 50 percent.

It seems evident that the natural control of the codling moth in the past or in unsprayed orchards today is not due to this parasite alone although it can be an important factor. All of the factors constituting the environmental resistance are not known.

In orchards which have been sufficiently well sprayed to control the codling moth the destruction of the parasites has not led to severe outbreaks necessarily. Poorly sprayed orchards in which the insecticide failed to control the codling moth have been subject to heavier infestations than completely neglected orchards. It would appear that if we are to control the codling moth with the present spray program we must do practically the whole job with chemicals.

The high codling moth population in poorly sprayed orchards leads to higher parasitism but not sufficient to prevent a high percentage of injured fruit.

III. A Comparison of the Long-Term Effect of a Copper Versus A Sulfur Fungicide Spray Program on the Prevalence of Codling Moth in the Hiltz-South Yarmouth Orchards at Berwick

This experiment was initiated in 1943 in two adjoining orchards which are under different ownership and managership. By arrangement with the owners the staff of the Dominion Entomological Laboratory at Annapolis Royal has been responsible for the spraying. The area comprising the two orchards has been divided into two plots which run right across both of them. The only fungicide used in one plot has been flotation sulfur, whereas a copper fungicide, either bordeaux mixture or a fixed copper (copper oxychloride sulfate) has been used in the other. Eight to nine sprays in all have been applied each season. Of these four to five have been cover sprays using lead arsenate 3-100 in the first three and cryolite in the remainder.

This experiment was designed for the purpose of comparing the long-term influence of the copper and sulfur fungicides on the fauna of apple trees.

The following table is a record of the incidence of codling moth injuries on fruit at harvest time each year during the period 1943-1948.

Note that the incidence of codling moth entries has been consistently higher in the sulfur sprayed area of each orchard. It has not been proven that this is due to the direct or indirect effect of the sulfur but circumstantial evidence indicates that it is. There is the possibility that the topography of the orchard area may have influenced the amount of fruit injury in the sulfur and copper sprayed areas since the former is located on higher ground than the latter. It is doubtful, however, that this is the explanation since similar differences in amount of injury are not found in the orchards lying on either side of the experimental orchards and on the same slope.

Year	Hiltz Orchard				South Yarmouth Orchard			
	Copper		Sulfur		Copper		Sulfur	
	Sting	Deep	Sting	Deep	Sting	Deep	Sting	Deep
			Variety Golden Russet					
1943	34	0.2	44	5	79	5	207	19
1944	25	3	64	5	2	1.5	16	1.5
1945	116	4	131	6	77	3	152	10
1946	22	2	63	10	5	0.1	22	1.2
1947	63	2	110	6	24	1	63	2
1948	97	11	175	31	29	1	76	7
			Variety Baldwin					
1943	17	0.2	35	1.4	79	2	165	6
1944	7	0.2	22	0.8	2.3	0.2	22	1.4
1945	88	1.4	158	4	77	2.7	155	4
1946	14	0.5	35	2.4	5	0.4	12	0.6
1947	25	0.2	119	1	16	0.2	32	0.3
1948	54	2	106	3	25	1	35	2

Combined Sprays for the Control of the Codling Moth and the European Red Mite in 1947 and the Residual Effect on the European Red Mite Population in 1948

A block of Northern Spy apple trees at Greenwich, Kings Co., Nova Scotia, which had a heavy infestation of the codling moth was the basis for experimental plots in the summer of 1947. Since the materials used on the plots caused different degrees of carry-over of winter eggs of the red mite a few observations on the red mite were continued into the following spring.

Spray Program in 1947

The owner applied preblossom sprays of bordeaux mixture and flotation sulfur and a calyx application of flotation sulfur with 5 pounds lead arsenate per 100 Imperial gallons. In the first and second cover sprays a fixed copper (C.O.C.S.) was applied along with the experimental insecticide and all the later sprays, without a fungicide, were applied by the staff of the Dominion Entomological Laboratory, Annapolis Royal.

The details of the materials used and the amounts per 100 Imperial gallons is given below. These sprays were applied as follows:

1st cover .... June 21st
2nd cover .... June 30th
3rd cover .... July 9th
4th cover .... July 19th
5th cover .... July 28th

Plot	Amounts Per 100 Imperial Gallons
1.	Lead arsenate, 4 lb., in 1st, 2nd and 3rd covers Synthetic cryolite, 3 lb. in 4th and 5th covers Summer oil, 3/4 gal., 1/2 gal. and 1/4 gal. in 3rd, 4th and 5th
2.	DDT, 2 lb. (50%) in 1st, 2nd and 4th covers Lead arsenate, 4 lb. in 3rd and 5th covers Summer oil, 3/4 gal. in 3rd and 1/4 gal. in 5th cover
3.	DDT, 2 lb. (50%) in all cover sprays Summer oil, 1 gal. in 3rd and 4th covers
4.	DDT, 2 lb. (50%) in all cover sprays DN-111, 1 lb. 13 oz. in 3rd and 4th covers
5.	DDT, 2 lb. (Gesarol AK50) in 1st cover Lead arsenate, 4 lb. in 2nd cover DDT and Xanthone, 2 lb. (Genicide A) in 3rd, 4th and 5th covers
6.	DDT, 2 lb. (50%) in all cover sprays

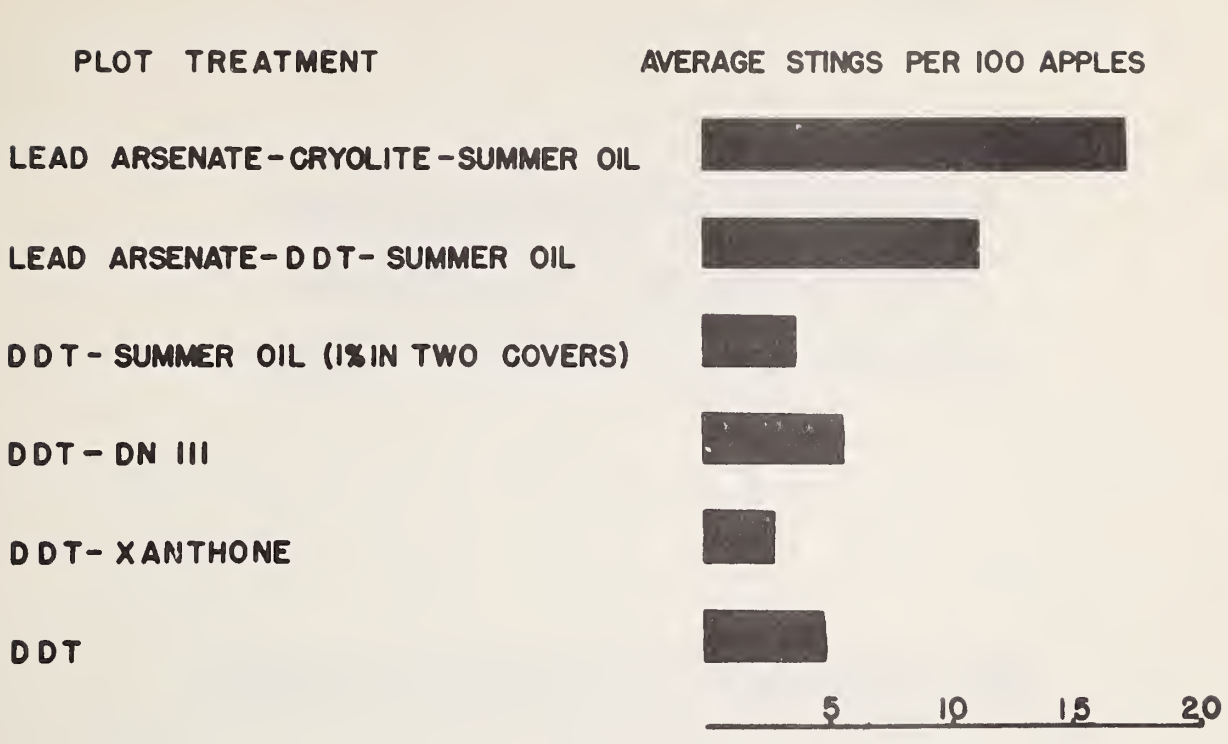
The results of these treatments in the summer of 1947 are illustrated in Figure 1.

Effect of 1947 Treatments on the Mite Population the Following Spring

The following spring (1948) the owner applied bordeaux mixture and Fermate sprays uniformly over the area which had constituted the experimental plots of the previous year. To follow up the possible after effect on the red mite populations, observations were made on the areas that had been the plots in 1947. Data on the amount of bronzing of the foliage in 1947, the carry-over of winter eggs in the twig axils and the build-up of mites in the spring of 1948 are given in the table below:

Plot	Damage to Foliage Summer, 1947	Mite Eggs Per Twig Axil Fall, 1947	Total Mites & Eggs/100 Leaves Spring, 1948	
			June 11	June 28
1.	Free from bronzing	7	80	1590
2.	Some bronzing toward end of season	23	1051	5546
3.	Bronzing light until end of summer	10	107	4182
4.	Moderate bronzing	38	1166	12052
5.	Built up to heavy bronzing late in summer	28	366	3502
6.	Bronzed early in the season; heavy defoliation late in season.	20	41	1020

In the areas which had been the DDT plots, except where the DDT was used without a miticide, there was a rapid build-up of the red mite the following spring. In the early part of the season predators were very scarce on these blocks. The predacious mirid Campyloma verbasci (Meyer) was moderately plentiful on the area which had been the lead arsenate and summer oil plot and this was the reason, in part at any rate, for the slower build-up of the red mite on this plot. On the DDT plot which had received no miticide the leaves had been bronzed early in the season of 1947; the result was that not only was there a reduction in the generation which lays the winter eggs but the winter eggs were laid earlier in the summer and fall than on the plots with more normal foliage. This suggests the possibility that winter mite eggs laid early in the summer are not viable.


CODLING MOTH STINGS - JOHNSON ORCHARD
PLOT TREATMENT
AVERAGE STINGS PER 100 APPLES
LEAD ARSENATE-CRYOLITE-SUMMER OIL
LEAD ARSENATE-DDT-SUMMER OIL
DDT-SUMMER OIL (1% IN TWO COVERS)
DDT-DN III
DDT-XANTHONE
DDT
5
10
15
20

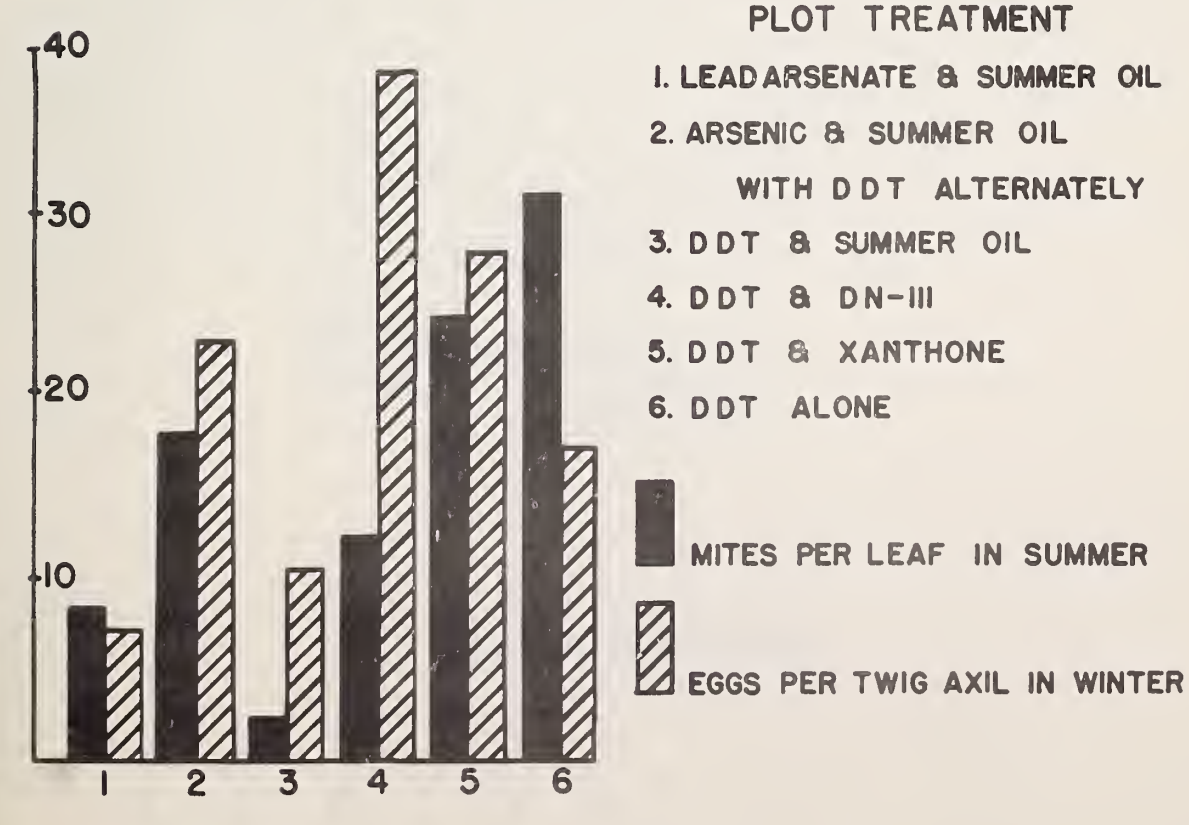

EUROPEAN RED MITES-JOHNSON ORCHARD
40
30
20
10
1
2
3
4
5
6
PLOT TREATMENT
1. LEAD ARSENATE & SUMMER OIL
2. ARSENIC & SUMMER OIL WITH DDT ALTERNATELY
3. DDT & SUMMER OIL
4. DDT & DN-III
5. DDT & XANTHONE
6. DDT ALONE
MITES PER LEAF IN SUMMER
EGGS PER TWIG AXIL IN WINTER

Figure I.

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March 1, 1949

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Administration

Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1948

Part II

Work Conducted by the Bureau of Entomology
and Plant Quarantine, Agricultural Research
Administration, U. S. Department of Agriculture

CURRENT SERIAL RECORDS
MAR 28 1949
U.S. DEPARTMENT OF AGRICULTURE

Not for Publication

(Not for Publication)

RESULTS OF CODLING MOTH INVESTIGATIONS, 1948

Part II

Work Conducted by the
Bureau of Entomology and Plant Quarantine,
Agricultural Research Administration,
U. S. Department of Agriculture.

This summary represents the contribution of the Divisions of Fruit Insect Investigations and Control Investigations of the Bureau of Entomology and Plant Quarantine to the pool of information on the results of codling moth investigations carried on during 1948 which has been prepared in accordance with a request made by the Committee on the Codling Moth of the American Association of Economic Entomologists. Because of the general interest in insect problems arising as a result of the use of DDT for codling moth control, information has been included on the more important ones that have come to notice, including orchard mites, the red-banded leaf roller, and the woolly apple aphid. As in previous years, this is a preliminary report, circulated for the information of those interested. It is subject to revision as further review of the data may indicate, and has the status of unpublished data, not subject to quotation without permission.

The work of the Division of Fruit Insect Investigations is carried on cooperatively with several Bureau and Department units, as well as with a number of State agencies. The Division of Insecticide Investigations has continued to contribute to the work reported herein, and joint field laboratories are maintained at Yakima, Washington, and Vincennes, Indiana. The Division of Control Investigations also maintains a field laboratory jointly with the Yakima laboratory. The work in West Virginia is carried on jointly by the West Virginia Agricultural Experiment Station and the Bureau; the work in New York is carried on similarly with the New York Agricultural Experiment Station.

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VINCENNES, INDIANA

L. F. Steiner, In Charge 1/

Seasonal Conditions and Development

Rainfall and mean daily temperatures at Vincennes for the seven-month period from April through October 1948 follow:

	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Precipitation (Inches)	3.61	4.99	4.95	6.62	0.66	3.10	4.24
Deviation from normal	-0.39	+0.90	+0.65	+3.12	-2.89	-0.61	+1.15
Mean daily temperatures (°F.)	60.0	63.4	74.6	77.5	76.4	70.9	54.8
Deviation from normal	+4.6	-2.7	-0.3	-1.6	-0.9	-0.2	-3.6

Temperatures as high as the low 80's late in March brought apple buds from complete dormancy to the green tip stage in less than 10 days. Fall and winter varieties were in full bloom April 17 to 19 and in the petal fall stage April 21 to 27. Harvest of early fall varieties occurred between August 28 and September 16 and of late varieties from September 15 to October 23. The first killing frost (26°F.) occurred October 16.

Codling Moth

Pupation began April 1, emergence April 24, and first hatch May 11. Not all larvae had pupated by June 1 and two major peaks of spring-brood moth activity occurred from May 9 to 11 and June 11 to 15. Second-brood hatch began June 29 and third-brood about August 10. Fruit became 20 percent wormy before June 30 in one orchard left unsprayed after the first cover spray and averaged more than 80 entrances per 100 apples in 2 unsprayed trees in another orchard.

Mites

European red mite eggs began hatching April 5 and the first 1948 eggs were laid April 23. Apparently because of abundant rainfall, two-spotted mites, Tetranychus bimaculatus, Harvey and Septanychus, n. sp., did not become abundant in most local orchards before late July although as many as 900 eggs and mites were found on a single red clover leaflet before the end of June. The new species of Septanychus was found in 23 of 26 commercial orchards. These orchards are distributed from the Michigan-Indiana line southwesterly to west central Tennessee.

1/ The chemical analyses reported herein were made by the Division of Insecticide Investigations, J. E. Fahey, In Charge.

Red-Banded Leaf Roller

Emergence began March 23. In contrast to early 1947, no parasites could be found. In 1947 one-third of the overwintering brood was parasitized. First-brood larvae began hatching April 19. Seventy percent of 197 egg masses under observation hatched April 24 to 26 during the petal fall period. Hatch was completed May 3. First-brood adults began appearing June 1 and second-brood larvae June 17, third-brood August 1 and fourth-brood the first week in September. Fourth-brood larvae fed for 50-60 days. Pupation among mature larvae on November 1 approximated only 7 percent. By November 18 pupation had increased to 26 percent. No fifth-brood larvae developed. In extreme northern Indiana this pest produced 3 full generations.

Forbes Scale (determinations by Dr. H. Morrison)

This scale was the only species found in our 2 principal experimental orchards. It also predominated in other apple orchards in the Vincennes area, although San Jose scale was found on apple trees near peach orchards. Crawlers began appearing on fruit late in June and fruit infestations increased rapidly until October. The infestation of Forbes scale throughout DDT sprayed orchards in the Middle West is probably the greatest on record.

Spray Materials Used

Unless otherwise stated, all formulas and discussion herein which mention quantities refer to the amounts used in 100 gal. of spray mixture and to the formulation rather than the active ingredient.

Abbreviations used to designate spray materials referred to in this report, along with the brands or sources of supply follow:

Azobenzene (20% wettable on tobacco dust. Tob. By Prod. & Chem. Corp.)
B-1956 (Glycerol phthalic alkyl resin emulsifier. Rohm and Haas)
Bdx. (3/4:1-1/2:100 Bordeaux mixture)
BS (Kolofog. Fused bentonite sulfur. Niagara Sprayer and Chem. Co.)
Coll. DDT (Colloidal DDT 40%. Michigan Chemical Co.)
CR-1639 wettable (Dinitro capryl phenyl crotonate (25%). Rohm and Haas)
CR-1639 emulsion (do.)
DDT-25 (25% DDT tech., 5% Wyo. bent.,70% Attaclay. Processed in laboratory mikropulverizer by J. E. Fahey)
DDT-50 (50% wettable. Michigan Chem. Co.)
Dimite (25% emulsion of di (p-chlorophenyl methylcarbinol).Sherwin-Williams)
DN Dry Mix (dinitro-ortho-cresol. Niagara Sprayer & Chem. Co.)
DN-111 (20% formulation of dinitro-o-cyclohexylphenol,dicyclohexylamine salt)
DN-289 (contains dinitro-o-sec-butyl-phenol)
IN-4200 ("Lorol"-2-thiozolinyl sulfide. DuPont)
Karb. ("Karbam", ferric dimethyl dithiocarbamate. Sherwin-Williams)
LA (acid lead arsenate, Acme brand)
Li (hydrated spray lime)
MB (Mississippi bentonite. Filtrol Corp. X-415)

MEP (20% methyl ether of pentachlorophenol in tobacco carrier.Tob.By-Prod.)
Naug. 83N (a mixed alkyl sulfite. Naugatuck Chem. Co.)
Naug. L-48 (aryl alkyl sulfonate. Naugatuck Chem. Co.)
Neotran (40% di (4-4'-chlorophenoxy) methane, C-890 formulation. Dow Chem.)
NS (nicotine sulfate, 40%)
Oil (Standard Oil Co. "Superla" summer spray oil)
Para. (25% Thiophos 3422 parathion)
Rhothane (25% emulsion of TDE. Rohm and Haas Co.)
S (wettable sulfur, "Mulsoid". Sherwin-Williams)
Shell oil (Helix ACX-45 "Superior type" raw dormant oil)
Shell emulsible (Helix ACX-197 "Superior type" emulsible dormant oil)
Stanofide (Standard Oil Co. fungicide)
TEPP (tetraethyl pyrophosphate, 40%. Victor Chemical Works)
Texas Libra oil (dormant type raw oil)
Toxaphene (25% wettable. Hercules Powder Co.)
Velsicol 104 (25% wettable powder experimental insecticide. Velsicol Corp.)
WB (Wyoming bentonite. American Colloid Co.)

Laboratory Experiments (January to March, 1948)

The larvicidal (codling moth) efficiency of parathion was not significantly affected by the use of wettable sulfur, Karbam, Puratized, or bordeaux mixture as supplements. The efficiency of DDT was reduced by the addition of toxaphene. Parathion or MEP each improved the initial effectiveness of DDT and aided in the maintenance of a high residual efficiency.

Parathion residues proved much more toxic to codling moth adults than residues left by comparable amounts of DDT. Residues (on glass) from 3 lbs. parathion per 100 gallons had a strong fumigating effect on the moths even when 10 days old and the contact effect was undiminished when 17 days old. Exposures of only 1 hour to the parathion residues resulted in complete mortality in from 24 to 48 hours in all tests. Deposits of DDT required from 1 to 2 days longer. Under field conditions, however, 5 to 12-day old residues from sprays containing 2 pounds parathion per 100 gallons were slightly less effective in reducing codling moth oviposition than those from 2 pounds DDT. Bait trap catches indicated that parathion sprays were at least as effective as DDT in reducing the moth population during the first few days after the application.

While conducting tests of miticides it was found that the new species of Septanychus could not reproduce on lima bean plants. In one test with paired plants, the progeny of 10 hibernating females numbered 13 mites and 10 eggs after 8 days and only 6 mites and no eggs after 13 days while 10 T. bimaculatus females increased to 173 mites and 109 eggs in 8 days and 1,965 mites and 2,723 eggs in 13 days, second generation mites having reached maturity. No apparent difference in their susceptibility to miticides has appeared in commercial orchards where Septanychus n. sp. caused as much damage in both 1947 and 1948 as T. bimaculatus.

Laboratory-Field Experiments

The usual method of conducting these experiments was followed (Bureau Circular E-448, September, 1939). Approximately 17,000 apples and 170,000 newly hatched larvae were used in the tests. Each efficiency determination required the use of 500 to 600 larvae and a stratified sample of 50 to 60 apples from 2 or more trees in field-sprayed plots.

Sprays were thoroughly applied with conventional equipment from tower and ground unless otherwise stated, and to the point of run-off from all parts of the trees. The pressure was held at 600 pounds per square inch.

Series A and B tests were conducted on mature Golden Delicious trees, Series C on young Rome Beauty trees about 18-20 feet high.

Series A

Fourteen treatments, most of which included DDT and a miticide, were tested from June 11 following the fourth cover and first use of the miticide to July 13 before the sixth cover.

Neotran (2 pound) and CR-1639 wettable (1 pound) when used in combination with 1.5 pound of DDT reduced its residual efficiency. The CR-1639 obviously contained too much wetting agent and either form when used alone had a very low larvicidal efficiency. MEP (1.5 pound), toxaphene (2 pound), the Naugatuck miticides 83-N (1 pint) and L-48 (2 pound), and IN-4200 (1 pint) either had no adverse effect on the efficiency of DDT or improved it. Parathion at quantities as low as 4 ounces per 100 gallons significantly improved the effi ciency as was first reported in 1947.

Neither bentonite sulfur (4 pound), wettable sulfur (4 pound), Karbam (2 pound) or Stañofide (0.5 pint) when used with parathion (2 pound) in sprays 2 to 4 inclusive had any adverse effect on the larvicidal efficiency of the latter. As miticides, parathion, Neotran, and toxaphene proved most effective up to two weeks after the second miticide spray, permitting less than 1 mite per leaf compared to 30 on the DDT check plot. By August 3, mite populations (mostly T. bimaculatus) on these plots ranged from 22 (Neotran) to 105 (CR-1639) mites per leaf which illustrates the ineffectiveness of early applications of miticides for the control of spider mites.

Series B. Combination Laboratory-Field and Field Experiments

These tests included replicated treatments on which field infestation data were also obtained (Series 2). Such treatments contained 3 replicates of 3 trees each. Lead arsenate, lime, and wettable sulfur were used in the calyx spray, and lead arsenate 4 pound + Karbam 1.5 pound in the first cover (applied May 6-7). Cover sprays 2 to 7 were applied May 14, 24, June 4, 18, July 14 and August 5.

Larvicidal efficiencies after most of the cover sprays were at or very close to 100 percent. Since several of the treatments were alike prior to the last 2 cover sprays the data of most interest are the efficiencies after 20, 24, 25, or 39 days of weathering. These data are averaged in Table 1, which also shows the final codling moth infestation and the average populations of mites from July through September. Efficiency differences earlier in the season, the fumigating effect of parathion, interplot moth migration and other factors account for most of the apparent discrepancies between the larvicidal efficiencies and the final infestation data.

When all the efficiency determinations are considered, Colloidal DDT (22) was less effective than either the 50 or 25 percent wettable powder. Its larvicidal efficiency from 12 ounces actual DDT was inferior early in the season to the 8 ounces used in treatment 29, although its residual efficiency during dry weather after the last spray was superior. This formulation contains too much wetting agent. Furthermore some of the DDT is in solution and when mixed with water forms crystals much larger than the DDT in wettable powders.

The miticides DN-111 and Dimite improved the residual efficiency of DDT after the last spray but decreased it after the 6th following 7 inches of rainfall during the 20 day period.

The 25 percent DDT was formulated with the same supplements used in the 25 percent parathion formula. There was no evidence that the combinations of parathion and DDT resulted in synergy. On plot 27, 0.25 pound of parathion was substituted for 1 pound of DDT-25 as used on plot 23 with a substantial improvement in control.

The trees used for these tests had dense foliage and low hanging branches. The application made only from the tower to plot 26 gave as good results as obtained on plot 25. The tower gun was operated approximately 15 feet above ground but all accessible fruit was sprayed at a saving of 20 to 25 percent in material, and 30 percent in labor, but with some slight loss in time. Although the residual efficiencies on plots 18 and 19 were equal, codling moth control was poorer in the latter. Mite control was satisfactory on both plots 19 and 26. At the end of June, worm entrances averaged 24 per tree on plot 1, 9 on plot 19, 2 to 7 on plots 21, 22, 23, and 24 and none on the other plots.

In this orchard the red-banded leaf roller injured 17 percent of the crop in 1946 but lead arsenate or parathion as used in 1948 held injury to from 0.2 percent (plot 26) to 1.0 percent (plot 23).

Although the average mite populations suggest that Dimite (20) proved superior to parathion (21) when used in the last 2 sprays, the larger average population on plot 21 resulted from a population of 41 mites per leaf on July 9 before the first miticide spray compared to 4 per leaf on plot 20. The averages give a better estimate of spray program performance than of miticide efficiency since some miticides were used in earlier sprays on other plots.

Table 1. Larvicidal Efficiencies, Codling Moth Injury and Mite Populations. Meyer Orchard. Vincennes, Ind. 1948

Plot	Quantities materials used in sprays 2 1/ to 7 (May 14 to August 6)	Codling Moth			Mites Per 100 leaves 3/	
		Average 2/ Larvicidal Efficiency	Apples Injured	Worm Entrances Per Tree	ERM	SM
		Percent	Percent	Number		
1	NS 1 pt.+MB 8 lb.+Oil 2 qt. (Karb.replaced oil in spray 2)	-	11.1	216	13	163
17	DDT-50, 1.5 lb. (LA 3lb.+Karb.1 lb. in spray 5)	69.2	11.9	191	498	2128
18	Same as 17 + DN-111,1.25 lb. in sprays 6 and 7	72.2	7.8	89	58	299
19	Same as 18 applied from tower only	73.8	10.2	177	178	278
20	Same as 17 + Dimite 1 pt. in sprays 6 and 7	78.2	8.3	99	46	161
21	Same as 17 + Para. 1 lb. in sprays 6 and 7	86.0	7.2	105	124	958
22	Coll. DDT, 1 lb. 14 oz. (TEPP 2 oz. in spray 7) (LA 3 lb. + Karb. 1 lb. in spray 5)	59.1	11.1	174	97	557
23	DDT-25, 3 lb.	73.9	11.7	170	103	873
24	Para. 2 lb.	94.0	7.1	87	9	91
25	DDT-25, 2 lb. + Para. 1 lb.	85.6	4.0	33	10	114
26	Same as 25 applied from tower only	84.2	3.8	30	54	189
27	DDT-25, 2 lb. + Para. 0.25 lb.	79.0	9.9	90	51	314
28	Para. 1 lb.	80.3	-	-	31	212
29	DDT-25, 2 lb.	56.8	-	-	137	665
30	DDT-25, 1 lb. + Para. 0.5 lb.	79.9	-	-	19	336

1/ Wettable sulfur 4 lbs. was included with cover spray 2 in treatments 17 to 23, and 25 to 30 inclusive.

2/ Average efficiency of weathered deposits on July 12, Aug. 3, 30, and Sept. 13 from 20 to 39 days after their application.

3/ Average of populations on July 9, Aug. 3, 9, 23 and Sept. 30.

Series C

These tests were designed to compare the larvicidal efficiencies of DDT and DDT + parathion during long periods of weathering. They include 2 plots sprayed with a Buffalo Turbine blower and 6-nozzle fish tail but with the spray material pumped into the air stream at 150 and 600 pounds pressure from a conventional sprayer on the tow truck.

A first cover spray of lead arsenate 4 pound and Karbam 1.5 pound per 100 gallons was applied May 5 and a special fungicide spray of Karbam 1.5 pound on May 17. The test treatments were varied as follows in 3 sprays applied May 28, June 28 and July 27 and were designed to apply the same amount of insecticide (dry formulation) per tree to all plots.

Plot	Materials per 100 gallons
35	DDT-50, 3 lb.
36	Parathion, 3 lb.
39	DDT-50, 2 lb. + parathion 1 lb.
42	DDT-50, 44 lb. + parathion 22 lb. Applied at 600 lb. pressure, 3 trees per minute from opposite sides.
43	Same as 42 applied at 150 lbs. pressure 1.5 trees per minute.

The above series includedother combinations of parathion, or parathion + DDT supplemented by Colloidal Z-1 (4 ounces) or Armour sticker (1.5 pound). Both adhesives reduced the effectiveness of the insecticides.

The results in detail are given in Table 2.

Table 2. Percent Larvicidal Efficiencies and Deposits of DDT and Parathion (in mg/cm²). Series C Plots. Reed Orchard.

		Age of deposits and date of sampling									
		Fresh	4 da.	12 da.	31 da.	1 da.	21 da.	29 da.	1 da.	23 da.	41 da.
Plot		5/28	6/1	6/9	6/28	6/29	7/19	7/27	7/28	8/30	9/7
35	Effic.	-	96.7	73.8	41.6	100.0	91.1	85.8	100.0	94.6	80.6
	DDT	19.2	12.1	2.2	0.9	11.9	3.8	3.3	11.2	7.4	4.2
36	Effic.	-	100.0	93.2	53.3	100.0	93.5	96.1	100.0	95.2	83.6
	Par.	4.9	1.8	0.5	0.06	4.9	0.44	0.20	4.1	0.67	0.25
39	Effic.	-	100.0	87.2	64.6	100.0	92.8	91.7	100.0	97.9	87.6
	DDT	15.7	8.3	2.1	1.2	9.2	2.9	3.0	9.6	6.5	3.0
	Par.	3.4	0.8	0.3	0.07	0.8	0.08	0.06	0.6	0.12	0.03
42	Effic.	-	98.0	71.5	41.6	100.0	76.4	81.5	100.0	78.7	62.1
	DDT	20.6	10.3	1.7	1.1	14.5	2.1	2.6	9.5	4.8	2.0
	Par.	3.0	1.6	0.3	0.06	3.2	0.12	0.09	1.5	0.14	0.07
43	Effic.	-	92.5	52.4	37.0	100.0	71.6	74.0	99.2	61.4	49.7
	DDT	14.3	8.5	1.2	1.0	9.7	3.2	2.5	10.9	2.5	2.0
	Par.	2.9	1.1	0.2	0.04	1.8	0.10	0.08	1.2	0.07	0.04
LSD Odds 19:1			5.2	7.2	11.3	-	5.6	5.7	-	6.8	7.7
Inches rainfall after last spray		0	0	1.70	4.22	0.04	3.23	5.30	2.25	3.22	4.97

Because of the toxicity of both DDT and parathion to codling moths and of foliage deposits to larvae, larvicidal efficiencies of 80 percent or more will generally insure good control of moderate codling moth infestations. Efficiencies above 90 percent will insure good control of heavy infestations. Lengthening the interval between sprays reduces the effectiveness of the treatments against moths, however, these tests indicate that except for a period in late June a 3-spray schedule of DDT or parathion alone or in combination at the strengths used might be successful in controlling codling moth. An additional spray would be needed in June to compensate for the rapid growth and loss of deposit aggravated by the loss of pubescence from the fruit.

Even after 4 to 6 weeks of weathering and growth, parathion (25%) at 3 pounds gave as good results as 3 pounds of 50 percent DDT. A 1 to 2 mixture of these materials was equally if not more effective.

Contrary to expectations the smaller droplet size resulting from the 600 pound pressure application with the Buffalo Turbine produced higher larvicidal efficiencies than the same amount of material applied at 150 pounds pressure and a 100 percent increase in air displacement. On both plots deposits were conspicuously heavy on the outside of the fruit and were in the form of thick spots. These spread during the first rain and thus gave some protection to the unprotected side of the fruit through redeposition from other fruit and foliage except in the tops of the trees. However, the less even distribution on plots 42 and 43 as compared to plot 39 resulted in much lower larvicidal efficiencies on the former plots even though the total deposits were generally similar.

The 2 May and June sprays were applied in the daytime under quick drying conditions. The Buffalo Turbine applications on July 27 were made at night and only 5 hours before a rain totalling 2.25 inches most of which fell in 45 minutes.

Although in larvicidal efficiency tests a given quantity of parathion (actual) appears equal to from 2 to 3 times as much DDT (actual) for codling moth control this is true only in the prevention of successful entrances.

Larvicidal efficiencies are calculated on the basis of successful entrances with stings disregarded. The 1947 experiments proved that at the lower deposit levels, parathion permitted many more stings in proportion to entrances than did DDT.

The following data show the average percent entrances as compared to percent stings for both materials at the deposit levels encountered in the laboratory field tests. Each material was used alone or with non-insecticidal supplements. Deposits are in mmg. per sq. cm.

Parathion -	Range of deposit	.05-0.5	0.51-1.0	1.01-2.0	2.01-4.0	4.01-6.0
(65 tests	Percent worms	10.8	3.4	1.8	0.3	0
36,000 larvae)	Percent stings	19.4	16.6	12.1	5.1	0.2
	Number of tests	25	11	6	19	4

DDT -	Range of deposit	0.1-2.0	2.1-4.0	4.1-8.0	8.1-16.0
(43 tests,	Percent worms	30.0	18.5	12.4	1.0
25,000 larvae)	Percent stings	3.4	5.1	5.3	0.6
	Number of tests	1	9	16	17

Because of the greater susceptibility of parathion to weathering a much greater range in its deposits was encountered than with DDT. Parathion deposits of 1 to 2 mmg. per sq. cm. which produced a larvicidal efficiency of 97 to 98 percent permitted 12 percent stings while DDT deposits of 8 or more mmg. producing approximately the same larvicidal efficiency permitted less than 1 percent stings. This difference was reflected in field results in 1947 but was less evident in 1948 field tests.

Larvicidal Efficiency of Rhothane (TDE)

Because of the promise shown by Rhothane for control of the red-banded leaf roller and the need for information on its toxicity to codling moth, a limited amount of larvicidal efficiency data were obtained late in the season. These follow:

Final spray applied Aug. 9 (Series 4 plots)	Percent larvicidal efficiency Sept. 7	Sept. 23
1a. Two second-brood sprays. DDT-50, 1.5 lb. + parathion 0.5 lb.	88.5	80.3
1b. Two second-brood sprays. Rhothane 1 qt.	40.3	34.7
2. Two second-brood sprays. DDT-50, 2 lb.	-	85.7
4. Two second-brood sprays. Parathion 2 lb.	-	68.4
Single spray applied Sept. 4. Last previous DDT spray applied Aug.2 by grower		
44. DDT-50, 1 lb.	96.4	92.9
45. DDT-50, 1 lb. + Rhothane 1 qt.	99.7	93.9
46. Rhothane 1 qt.	92.4	86.1
L. S. D. Odds 19:1	7.7	4.2

Although 1 quart of the Rhothane emulsion per 100 gallons is the maximum needed for leaf roller control it will not give adequate protection against codling moth. It can, however, be combined with wettable DDT with good results. There is some danger from separation or "buttering out" of the DDT. A wettable TDE powder would be preferable for use in combination with wettable DDT.

Field Testing of Insecticides on Randomized Plots

Small plot tests were conducted in which the infestations of codling moth, red-banded leaf roller, Forbes scale and mites along with rosy apple aphid injury were determined for the entire crop. Information on the control of the European red mite and the two-spotted spider mite were obtained by taking 1 or more samples of 100 leaves from each plot (all trees represented) at frequent intervals during the season. The brush machine and counting technique developed by C. F. Henderson was used to measure the mite populations. Egg counts were also made but are not included herein. Scale injury was compared by determining the percentage of fruit infested with crawlers. Only apples deformed by aphids were included in estimates of aphid injury. Many more were undersize. Sprays were applied with conventional equipment as described under Laboratory-Field Tests.

Series 1. Varieties: Jonathan, Starking, Rome Beauty and Winesap.
6 replicates, 2 trees each.

The 16 plots in this series were arranged in an L-shaped area in the angle of which a block of trees had been removed in February and left in piles. From these a heavy flight of codling moth and leaf roller adults migrated to the plots. Codling moths emerged from the piles until mid-July.

The trees were mature and required an average of 35 to 40 gallons each per spray application. The area was sprayed uniformly by the grower through the calyx application. No dormant spray was applied. The calyx spray applied April 21 to 27 included LA 4 pound, DDT-50, 1 pound, Li. 3 pound, and BS 6 pound.

The materials used in cover sprays 2 to 8 and their dates of application are given in Table 3. The eighth cover spray was omitted from the Jonathan and Starking varieties.

The object of the differentiation in the first cover spray was to precede oil with Karbam rather than sulfur (1 to 4), and to rely on subsequent parathion sprays rather than a first cover of lead arsenate for leaf roller control (11 to 15 incl.).

The more important data are given in Table 4. Since practically no scale reached the fruit on Rome Beauty and Starking varieties the scale infestation data apply to Winesap and Jonathan, the former being the most heavily infested.

Table 3. Spray Treatments Applied to Series 1 Plots, Reed Orchards 1948.

1st - April 29-30	4th - June 2-3	7th - July 28-29
2nd - May 11-13	5th - June 16-17	8th - Aug. 19 (omitted from
3rd - May 20-21	6th - July 7-8	Jonathan and Starking)

Plot	Quantities Materials Per 100 Gals.
1,2,3.	1st cover - LA 4 lb. + Karb. 2 lb. (2nd cover included Karb. 1 lb. except plot 3)
1	NS 1 pt. + MB 8 lb. + Oil 2 qt.
2	LA 2 lb. + DDT-50, 1 lb. + Oil 2 qt. + Bdx. (except in 2nd cover) sprays 2 to 5. Same as plot 3 after spray 5.
3	NS 0.5 pt. + MB 4 lb. + Oil 2 qt. + DDT-50, 1 lb.
4	1st cover - Karb. 2 lb.
	NS 0.5 pt. + MB 4 lb. + Oil 1 qt. + Para. 0.5 lb.
5,6,7,8,9,10,16.	1st cover - LA 4 lb. + Li. 4 lb. + S 6 lb. (2nd cover included BS 5 lb.)
5	DDT-50, 2 lb.
6	Same as pl. 5 + DN-111, 1.25 lb. in sprays 5, 6, 7.
7	Same as pl. 5 + TEPP 4 oz. in sprays 5, 6, 7.
8	Same as pl. 5 + Para. 0.5 lb. in sprays 5, 6, 7.
9	Same as pl. 5 + Para. 0.25 lb.
10	Same as pl. 5 + Neotran 1 lb.
16	DDT-50, 3 lb. sprays 2, 3, 5 and 7 + Dimite 1 pt. in sprays 5 and 7. Sprays 4, 6, 8 omitted.
12.	1st cover - Para. 1 lb. + S 6 lb. (2nd cover included BS 5 lb.)
	Same as pl. 5 in sprays 2, 3, 5, 6, and 8. Same as pl. 11 in sprays 4 and 7.
11,13,14,15.	1st cover - S 6 lb. (2nd cover included Karb. 1 lb. except pl.15)
11	DDT-50, 1 lb. + Para. 1 lb.
13	DDT-50, 1.5 lb. + Para. 0.5 lb. sprays 2 to 5. Same as pl. 5 thereafter
14	Para. 2 lb.
15	Duplicate of pl. 16 except Para. 1 lb. substituted for Dimite and DDT in spray 7 reduced to 2 lb.

Table 4. Results Series 1. Reed Orchards

Plot	Codling Moth Entrances per tree 1st-br.	Codling Moth Entrances per tree Season	Codling Moth Percent Wormy	% apples affected by RBLR	% apples affected by Scale	% apples affected by Aphids	Ave. No. Mites per 100 leaves 1/ ERM	Ave. No. Mites per 100 leaves 1/ 2-SM
1	14	78	2.4	8.9	5.1	1.8	70	59
2	6	60	1.0	2.2	5.8	3.6	34	480
3	8	14	0.4	7.8	1.2	5.5	62	358
4	24	44	0.9	3.4	0	3.2	56	18
5	10	78	1.7	13.8	39.3	1.5	604	1524
6	do.	112	2.1	12.4	44.6	1.8	309	86
7	do.	133	2.6	13.3	55.6	2.2	628	166
8	39	50	1.1	4.6	0	2.5	275	32
9	0	16	0.4	3.3	0	2.1	182	58
10	9	64	1.1	11.6	45.6	2.7	156	130
11	8	39	0.7	5.2	0	4.6	95	100
12	26	86	2.0	6.9	0	2.6	190	128
13	0	20	0.4	8.5	0	2.6	190	388
14	9	47	0.9	4.9	0	4.4	62	28
15	28	50	1.0	11.3	0.1	2.2	128	292
16	55	290	4.6	17.0	65.0	2.6	272	60

1/ Average of populations (on 2 to 4 samples of 100 leaves each) recorded on June 15, July 7, 26, Aug. 2, 18, 23 (RB and W only) and Sept. 17.

Yields: Differences in average yields of more than 1,100 apples were significant at odds of 19:1. Individual tree yields ranged from 1,360 to 7,600 apples, the two extremes being in the same treatment (7). Fruit set apparently was adversely affected by the early use of oil on plots 1, 3, and possibly 4, where the yields averaged 3,148, 3,072 and 3,818 apples respectively. Differences among the other plots are not believed to have been caused by the spray treatments. On these the yields ranged from 4,206 to 5,670 apples.

Codling Moth: The proximity of certain replicates on the inside borders of the L-shaped area to the piles of trees resulted in their getting a severe late first-brood attack. At the end of June the 17 record trees nearest the piles of trees averaged 40 worm entrances (in fruit) per tree compared to only 11 per tree for the other 79 trees. The season's totals were 3 times as great on the 17 trees and 6 times on the 79. Certain of the 17 trees, especially in plots 4 and 8 had more fresh entrances late in June than successful entrances by the end of the season. Many of the late June worms were killed by the July 7 spray. Another source of reinfestation was a Duchess and Transparent planting adjacent to one corner of the area. The 7 replicates nearest this planting averaged 25 entrances per tree at the end of June. The final infestation increased to 239. The Winesap replicate of plot 16 contained 1,145 worm entrances. If this treatment is excluded from the analysis of variance a difference among treatments 1 to 15 of 56 worm entrances per tree is required for significance at odds of 19:1. Otherwise the required difference is 114.

Best control in the first-brood period was obtained with treatments 2, 3, 5, 9, 10, 11, 13 and 14. Best control for the season was effected by treatments 3, 4, 8, 9, 11, 13, 14 and 15. The least stung fruit (1.1 to 1.8 percent) was on plots 2, 3, 9, 13 and 15 and the most (3.5 to 4.8 percent) on plots 8 and 16.

Treatment 16 was least effective, only one of its 6 replicates having less than 136 worm entrances. Dimite (16), DN-111 (6), and TEPP (7) may have reduced the effectiveness of DDT at a critical time during second-brood attack by causing too much run-off. On plot 15, parathion supplemented the DDT sufficiently to permit omitting 3 sprays although almost as much DDT was used as on plot 5. The standard tank-mixed nicotine bentonite oil treatment (1) in this series compared favorably with the other treatments doubtless because of the preponderance of DDT and parathion treatments and their effect on its moth population.

Red-Banded Leaf Roller: The comparatively rapid disappearance of effective parathion residues from the foliage late in the season resulted in little protection against the fourth-brood progeny of leaf roller moths which originated in non-parathion plots. In the absence of an outside source of reinfestation the parathion treatments would all have given excellent control since there were very few third-brood larvae on these trees.

For example, in the two replications (Rome Beauty) where the late-season buildup was greatest, an average of 27 injured drops per tree had been collected through Sept. 9 in the 8 plots on which parathion was used. Only 6 per tree were found in treatment 14. The final infestation amounted to an average of 338 injured apples per tree (295 on pl. 14). In contrast only 18 injured drops were collected from treatment 2 through Sept. 9 and only 63 apples per tree were injured during the season. The other 7 treatments averaged 165 injured drops by Sept. 9 and 614 injured apples for the season. Most apples injured by leaf rollers drop soon after the injury take place hence the infestation increased more than 3 times as rapidly on the parathion as the non-parathion treatments during the period of fourth-brood attack.

The heaviest leaf roller infestation occurred in plot 16, which supports evidence previously obtained that DDT becomes less effective against this pest as the frequency of application declines. Slightly lower infestations developed in treatments 5, 6, 7, 10 and 15 where (except in 15) DDT was used with materials ineffective against leaf rollers. Among the various parathion treatments, nos, 4, 8, 9, 11 and 14 gave best results. The use of parathion early in the season only (13), or after long intervals (12 and 15), was less successful in this type of plot arrangement. The best leaf roller control was obtained with treatment 2, one of the formulas suggested for grower use after the 1946 outbreak. On Oct. 5 foliage analyses by Mr. Fahey indicated that the As_2O_3 deposits on the Rome Beauty replicates of plot 2 averaged 22.2 micrograms per sq. cm. Lead arsenate was last applied on June 16, 111 days earlier. On trees in plot 5, where it was last applied on April 30, the As_2O_3 residue was down to 1.2 mmgs. Parathion residues ranged from 0.06 to 0.08 mmgs. per sq. cm. on the foliage of plots 4, 11 and 14.

Forbes Scale: The control of scale by parathion was remarkable and confirms our first observation of this effectiveness reported in 1947. The minimum number of applications needed, and the optimum timing and dilutions were not satisfactorily determined. However, 4 ounces or more per 100 gallons in 6 or 7 sprays or 0.5 pound in 3 consecutive applications gave complete control, the latter after crawlers had already become well established on the fruit in late June. Two applications of 1 pound as used on plot 15 gave almost complete control. A single application of 0.5 pound, July 17, on the unused tree in the Winesap replicate of treatment 16 greatly reduced the subsequent buildup of scale but 60 percent of the fruit was still lightly infested at harvest compared to 85 percent heavily infested on the regular record tree in this replicate sprayed with DDT and Dimite.

Fair control was obtained by summer oil and nicotine (nos. 1, 2, and 3). Serious infestations developed on all other plots, with from 39 (no. 5) to 65 (no. 16) percent of the fruit affected.

In November, examinations were made of both 1948 and older growth and of tree bodies in treatment 5, 8, 9 and 14. All scale found on nos. 8, 9 and 14 were dead. Except in treatment 9 none of the dead scale was out on 1948 growth. On the straight DDT plots (5) and similar plots where dormant oil sprays were applied, living scale was abundant on 1948, as well as older, growth.

The failure of dormant sprays to hold the scale infestation to the level of the previous year on Winesaps sprayed with treatment 5 is illustrated by the following data. The trees were thoroughly sprayed by the laboratory personnel with about 25 gallons per tree.

	Materials and quantities per 100 gal.	Date applied	Ave. percent fruit infested on two trees	Increase in scale above 1947 infestation
Check -	no dormant spray	-	40.2	133.2X
1	Texas Libra oil 3 gal. + WB 1 lb.	Mar.16	68.9	12.8X
2	No. 1 + DN-dry mix 1 lb.	Mar.16	41.6	2.8X
3	Shell Helix "Superior" oil 2 gal. + WB 1 lb.	Mar.16	8.0	7.0X
9	DN-289, 2 qt.	Mar.25	14.6	5.5X

Rosy Apple Aphid: Control of the rosy apple aphid was quite variable because most of the infestation was concentrated in certain parts of the block and the treatments were not equally exposed to attack. However, the data fail to indicate that parathion as used early in the season in treatments 4 and 14 was any more effective than DDT-50 at 2 pounds as used in treatments 5, 6, 7, 8 and 10. Since their use was delayed until the second cover spray these materials did not effect control until considerable damage was done, however, parathion when used in thefirst cover in treatment 12 gave no better results.

Orchard Mites: Wind drift of mites onto parathion-sprayed plots and the kill of mites by parathion (through fumigation) on non-parathion plots undoubtedly tended to level the mite populations, particularly since half the trees were sprayed with this material at concentrations proved to have a lethal effect on mites 80 ft. away.

In making comparisons of mite populations, allowance must be made for the repressive effect of the spider mite population in plot 5 (DDT check) on that plot's red mite infestation. The average populations of each species were given in Table 4.

As in previous years, summer oil with nicotine bentonite and DDT (plots 2 and 3) gave excellent control of red mites but only fair control of spider mites. DN-111 gave better results than TEPP as used on plots 6 and 7 but permitted a greater buildup of red mites in September. Parathion (8) gave better results than either. When used in all sprays 4 ounces (9) was about as effective except after the last spray as 1 pound (11). When used in 4 first-brood sprays (13) a moderate buildup in July and August was not avoided.

Series 3

This series includes 3 plots set up as single trees replicated 5 times on Rome Beauty and 3 on Turley. Since 1943 one plot has been sprayed exclusively with a lead arsenate program, one with nicotine bentonite and oil (lead arsenate in the calyx) and the third with DDT (plus lead arsenate in certain 1948 sprays).

The object has been to observe the effects of the treatments on yields over a period of years. The annual yields per tree in numbers of apples and bushels follow:

Insecticide		1943 1/	1944	1945	1946	1947	1948	Average '45-'48
Lead arsenate 2/ + bordeaux	Apples	3310	2500	2270	3830	3330	2530	2990
	Bu.	21	19	20	29	22	19	22.5
Nic. Bent. Oil	Apples	2810	1770	1600	3890	2400	2860	2680
	Bu.	19	14	15	27	16	21	19.8
DDT	Apples	3900	1620	3360	3920	4230	4280	3948
	Bu.	25	13	26	28	29	31	28.5

1/ All trees sprayed alike with lead arsenate and nicotine bentonite.

2/ Summer oil included in last 2 or 3 first-brood sprays.

The cover spray program can reduce yields the following year by causing injury to foliage or failing to control leafhoppers especially during the month after petal fall when fruit buds are formed. It can reduce yields during the current year by causing injury that results in the failure of the small apples to set. Lead arsenate may reduce yields both ways. Nicotine bentonite and oil may, in combination with sulfur residues from early sprays, also affect both the current year's and the following year's yield.

In these tests the trees were kept well pruned. They were located on a well drained and well fertilized clay loam soil in blue grass sod. DDT residues have not penetrated the soil to any extent but are still held in decomposing debris at the surface. Approximately 12.5 pounds of actual DDT have been applied per tree to date. The 1944 yields were lowest on DDT sprayed trees, probably because these trees had produced the most fruit in 1943 when they were all sprayed with either lead arsenate, nicotine bentonite or combinations of the two. After 1944 the yields on the DDT sprayed trees increased each year instead of fluctuating from high to low points as on other plots. Most varieties have produced greater yields when sprayed with nicotine bentonite than with lead arsenate but since the Turley variety is especially susceptible to oil injury and especially oil-sulfur shock the nicotine bentonite treatment produced lower average yields than the lead arsenate in this experiment. Furthermore since the lead arsenate trees were surrounded by trees sprayed with DDT, codling moth control on them was aided to such an extent that it was not necessary to apply the heavy arsenical program needed when the whole orchard was sprayed with it. Only 7 cover sprays were applied in 1946, 1947 and 1948.

It is important to note that the remainder of the 265-acre orchard in which the tests were conducted has been sprayed with DDT in all cover sprays since 1945 although some nicotine bentonite or lead arsenate was included in certain sprays. For the last 3 years, beginning in 1946, this orchard has broken all its previous production records. Its 1946 record was made despite an almost complete loss of crop on 35 acres from frost damage. Its 1947 yield was 14 percent greater than in 1946 despite a similar amount of frost damage while the 1948 yield increased 22 percent over 1947 despite the removal of 50 acres of mature trees. These experiments are still in a preliminary stage. The amount of DDT accumulating in the soil may at present have a stimulating effect on the apple trees but at some future date may reach a level where it becomes injurious.

Series 4. Rome Beauty, 4 replicates of 6 trees each. Reed Orchard.

This experiment was set up in a block where the red-banded leaf roller injured 65 percent of the crop in 1946. Six treatments were initiated but one was subdivided after the 4th of 6 cover sprays. Infestation data were obtained from 2 average trees per replicate except plot 1-b where only 1 was available. Spray treatments are outlined in Table 5 and results in Table 6.

The use of DDT in the calyx spray helped in restricting the spread of rosy aphids to bearing spurs other than those on which they were feeding at that time. By using parathion 10 days later in the first cover spray on plots 4, 5, and 6 this pest was practically annihilated. However, on plots 1 to 3 inclusive, only lead arsenate was used in the first cover spray and it was not until 22 days after the petal fall spray that sprays containing DDT were resumed. The result was a striking difference in fruit set, number of bushels, and of course size of fruit on the 2 groups of treatments. Aphid injury on plots 1 to 3 inclusive may have been aggravated by predator mortality caused by parathion fumigation, or by contact with its deposits on adjoining plots, in the case of mobile forms. The attack by the rosy apple aphid is believed to have caused many partially fertilized fruits to set that otherwise would have dropped. Many stunted fruits were not deformed by aphids, hence do not appear in the column headed "Aphids". The use of less DDT on plot 2, than on 1 and 3, resulted in more deformed fruit as well as fruit of smaller size. It is highly significant that the trees in plots 4, 5, and 6 produced as many bushels as those in plot 2 even though the latter produced 40 to 60 percent more apples. In plot 2, 31 percent of the bushels and 37.5 percent of the apples were left for the 4th and final picking. On plots 4, 5, and 6 most trees were stripped in the first 3 pickings and only 6.7 percent of the apples remained for the fourth.

No such differences were found among the treatments in Series 1 (Table 4) where DDT and parathion sprays were started concurrently. The value of DDT in the control of aphids has been reported in previous years. For this reason the grower used DDT in all sprays starting with the calyx. In rows adjacent to our plots 8 scattered trees sprayed by him averaged 2,720 apples per tree and only 0.6 percent deformed apples.

Table 5. Spray Treatments[1] Applied to Series 4 Plots. Vincennes, Ind. 1948

Plot	Materials per 100 gals.					
	1st cover 5/5-6	2nd cover 5/17-18	3rd cover 6/1	4th cover 6/14	5th cover 7/9	6th cover 8/9
1	LA 4 lb. Li 4 lb. BS 6 lb.	DDT-50,2 lb. BS 5.5 lb.	DDT-50,2 lb.	DDT-50,2 lb.	DDT-50,2 lb. DN-111, 1.25 lb.	DDT-50,2 lb. DN-111, 1.25 lb.
1-a	Part of Plot 1 until 5th cover				DDT-50, 1.5 lb. Para.0.5 lb.	DDT-50, 1.5 lb. Para.0.5 lb.
1-b	Part of Plot 1 until 5th cover				Rhothane, 1 qt.	Rhothane, 1 qt.
2	LA 4 lb. Li 4 lb. BS 6 lb.	LA 2 lb. DDT-50,1 lb. Li 2 lb. BS 5.5 lb.	LA 2 lb. DDT-50,1 lb. Oil 2 qt. Bdx.	LA 2 lb. DDT-50,1 lb. Oil 2 qt. Bdx.	DDT-50,2 lb.	DDT-50,2 lb.
3	LA 4 lb. Li 4 lb. BS 6 lb.	DDT-50,2 lb. BS 5.5 lb.	DDT-50,2 lb.	LA 4 lb. DDT 1 lb. Karb.1 lb.	DDT-50,2 lb. DN-111, 1.25 lb.	DDT-50,2 lb. DN-111, 1.25 lb.
4	Para.2 lb. Karb.1.5 lb.	Para.2 lb. Karb.1 lb.	Para.2 lb.	Same as 3rd cover in subsequent sprays		
5	Para.2 lb. Karb.1.5 lb.	DDT-50,2 lb. BS 5.5 lb.	DDT-50,2 lb.	DDT-50,1 lb. Para.1 lb.	DDT-50,2 lb.	DDT-50,1 lb. Para.1 lb.
6	DDT-50, 1.5 lb. Para.0.5 lb. Karb.1.5 lb.	DDT-50, 1.5 lb. Para.0.5 lb. Karb.1 lb.	DDT-50, 1.5 lb. Para.0.5 lb.	Same as 3rd cover in subsequent sprays		

1/ A uniform calyx spray containing 4 lbs. lead arsenate + 1 lb. DDT-50 + lime and wettable sulfur was applied about April 25. The dormant sprays were omitted.

Table 6. Series 4 Results

Plot	No. per tree Bu.	No. per tree Apples	Codling Moth % apples Clean	Codling Moth No. worms per tree	Percent Apples Injured By RBLR	Percent Apples Injured By Aphids	Percent Apples Injured By Scale	Ave. No. 1/ Mites per 100 leaves ERM	Ave. No. 1/ Mites per 100 leaves 2-SM
1	30	4,029	97.9	24	12.8	2.3	0.2	455	29
1-a	29	3,815	98.6	10	6.0	1.9	0	389	25
1-b	29	3,708	96.7	80	1.8	2.5	0.4	417	64
2	22	3,691	97.3	56	1.6	7.7	0.9	290	334
3	32	3,950	98.4	35	2.8	4.0	0.4	362	25
4	22	2,268	96.2	39	2.0	2.0	0	169	14
5	23	2,412	96.6	36	7.5	2.7	0	222	54
6	25	2,655	97.8	20	6.9	2.6	0	279	36

1/ Populations on July 8, 30, Aug. 20 and Sept. 23.

Among the 8 treatments tested, those receiving the most DDT (1, 1-a, 3 and 6) with or without parathion gave the best control of codling moth. Treatment 1-b with Rhothane alone in the last 3 sprays was least effective.

Plot 1, as anticipated, gave poor control of leaf rollers. Treatment 1-b and 2 gave best results against this pest. Treatment 2 has been outstanding for the past 3 years. All plots receiving parathion were maintaining excellent control until, as in Series 1, fourth-brood hatch began.

On August 9, before the final spray, parathion residues on the foliage ranged from .03 mmg. per sq. cm. (plot 6) to 0.14 mmgs. (plot 4). After the spray they were 0.59, 1.16 and 3.02 mmg. on plots 6, 5, and 4 respectively. On October 5 they ranged from 0.03 to 0.09 mmgs. As late as September 9 an average of only 2 drops per tree in plot 4 had been injured by leaf rollers compared to 105 in plot 1.

The scale population on the fruit was comparatively low, however, some scale were found in all plots except where parathion was used.

Although on May 5 there were as many as 500 red mites and eggs per 100 leaves on plots 1 and 3, the mite populations never threatened on any of these plots until after the last spray, however, DN-111 was included in the last 2 sprays applied to plots 1 and 3 as insurance against a later outbreak. Heavy mite infestations built up in grower-sprayed areas on 3 sides of the block. This difference is additional evidence that parathion in small-plot tests will retard mite development on trees not sprayed with it.

Spray Residues: Analyses by Mr. Fahey at the time of the first picking September 17, showed that the following average residues in PPM remained on the fruit.

Plot	DDT	As_2O_3	Parathion
1	6.3	0.25	-
2	6.9	2.15	-
3	4.4	1.70	-
4	-	-	0.21
5	3.1	-	.09
6	4.5	-	.06

Phytotoxicity of Parathion

No foliage injury or fruit drop on any variety resulted from the use of parathion (25%) at strengths up to 2 pounds per 100 gallons. However, on Golden Delicious (Series B) a severe russet began to be noticeable after 2 applications of parathion at 2 pounds per 100 gallons. This progressed until by July 1, 50 to 55 percent of the fruit surface was affected. The use of Karbam at 1.5 pound per 100 gallons in the first cover spray or the combination of Karbam at 1.5 pound and lead arsenate in that spray was believed responsible. This spray alone caused an increase in russet from 8 percent (trees unsprayed after petal fall) to from 10 to 22 percent where no parathion was used. No increase above these figures occurred where only 0.25 to 0.5 pound parathion was used. The addition of Karbam or sulfur to parathion (2 pounds) in four sprays caused no more russet than resulted from the application of parathion (2 pounds) over Karbam residues. Parathion at 1 pound applied alone or with DDT (plots 25, 26 and 28, Series B) russetted from 25 to 28 percent of the fruit surface.

On Jonathan 1 pound of 25 percent parathion with wettable sulfur, applied as the first cover spray (plot 12, Series 1), caused no russet, yet 2 pounds in combination with 1 pound of Karbam (plot 14, Series 1) started in the second cover caused considerable russet near the calyx end. No russet or other injury occurred on any other red varieties.

In 1947, Golden Delicious sprayed with 4 applications of 4 pounds of 15 percent parathion per 100 gallons after a second cover of lead arsenate plus 0.5 pound Karbam developed the best finish of any treatment used that year.

Effect of Summer Sprays on Mature Codling Moth Larvae

For the past 3 years we have noted that the use of DDT in regular codling moth spray programs, causes a substantial increase in winter mortality of hibernating larvae. Parathion may have an even greater effect. The results which follow are based on detailed examinations in March or April of all hibernating quarters on several trees in each treatment.

Treatment Previous Year	Percent mortality and year of observation 1946	1947	1948
Lead arsenate	-	8.6	-
Nicotine bentonite, oil	15.4	-	5.3
DDT	36.5	33.6	33.9
DDT (+ 1 lb. Para.(15%) in 1 spray)	-	-	76.5
Methoxychlor	-	9.9	

The time and mode of kill have not been determined. Presumably the cocooning larvae, include bits of bark impregnated with DDT or parathion in their cocoons or, while in search of cocooning quarters, pick up enough toxicant to cause death during the subsequent long period of contact. The parathion application was made in July, 1947 long before most of the hibernating larvae had hatched.

In August, 1948 single-tree plots replicated 4 times were sprayed with single applications of several formulas. The orchard was otherwise unsprayed and a large hibernating population should be available for survival studies in 1949. Untreated bands, placed on the trees before the spray applications, were removed in November and examined with the following results:

Plot	Treatment (Quantities are for 100 gal.)	Total No. larvae (4 trees)	Percent dead
1	DDT-25, 6 lb.	1,682	6.0
2 1/	No. 1 + B-1956, 2 oz. and oil 2 qt.	1,845	10.3
3	DDT-25, 4 lb. + Para. 1 lb.	1,840	80.2
4	No. 3 + B-1956, 2 oz. and oil 2 qt.	1,085	78.4
5	DDT-25, 12 lb.	1,985	9.3
6	Para. 4 lb.	2,379	93.3
7	DDT-25, 6 lb. + Para. 2 lb.	1,398	82.8

1/ Only the trunks and scaffold limbs in the underscored plots were sprayed.

The results suggest that parathion residues may be rapid enough in their action to effect a considerable kill of transforming as well as hibernating individuals. Nothing appears to have been gained by the addition of oil to DDT or DDT plus parathion. The mortality under bark on the trees sprayed with DDT is expected to increase during the winter.

Mortality of Codling Moth Larvae After Entrance in Fruit

Previous work indicated that sprays containing nicotine or DDT were effective against many larvae inside the fruit at the time of the application. A preliminary test of parathion was set up in an unsprayed heavily infested orchard. Sprays were applied June 24 near the end of first-brood attack. One hundred twenty five injured apples containing 170 to 240 entrances and stings were removed June 30 and a careful search made for dead and living larvae. Fourteen to 15 percent of the larvae (assuming no more than 1 injury each) had matured and left the fruit. On the unsprayed fruit 28 percent of the injuries contained living larvae. A spray of parathion (25%) at 4 ounces per 100 gallons left only 4 percent alive, 1 pound left 3 percent, 1 pound of DDT-50, 17 percent and 4 pounds 10 percent. More than 22 percent of the dead larvae found ranged from 1/4 to 1/2 inch in length. DDT appeared as effective as parathion in killing the larger larvae.

Special Tests with Miticides

Dormant Sprays for European Red Mite Control

Dormant oil sprays and early season applications of parathion were compared on duplicate 12-tree plots of the Rome Beauty variety. The oil treatments in addition to several others were repeated on single 4-tree plots on Turley and Winesap varieties. Heavy mite populations on the check plots late in June necessitated discontinuance of the experiment and the application of a miticide spray. The results obtained up to that time are given in Table 7.

All plots were given a standard DDT cover spray program. However, the Winesap check plot and part of Winesap plot 3 were subjected to fumigation from parathion applied to nearby trees. The maximum numbers of mites per 100 leaves observed on the Rome Beauty, Turley, and Winesap check plots were 3,356, 6,084 and 377 respectively.

The results with a 2 percent "Superior type" oil were in line with those reported in the past by the New York Agricultural Experiment Station.2/ Where tank mixed with bentonite better results were obtained than with bordeaux or with an emulsible formulation of the same oil. Parathion, substituted for lead arsenate in the calyx spray, gave as good control as 3 percent dormant oil but when not used until the first cover spray or after mites began depositing eggs, the parathion was much less effective.

Forbes scale infested from 0.1 to 0.2 percent of the apples on Rome Beauty plots 4 and 5, 0.1 to 0.5 percent on plots 1 to 3, and 1.4 percent on the check. The scale infestations on the Winesap plots were discussed under Series 1.

2/ The blood albumin emulsifier recommended appears unsuitable for use in spray waters locally available.

Table 7. Control of European Red Mite with Dormant or Early Season Sprays

Treatment 1/ (Quantities for 100 gal.)		Ave. number mites per 100 leaves, 6 examinations 2/		
		Rome Beauty	Turley	Winesap
Check - none for mites		812	1,144	140
1	Texas Libra oil 3 gal. + Wyo.bent. 1 lb.	45	163	211
2	No. 1 + DN-Dry Mix 1.25 lb.	79	24	17
3	Shell Helix "Superior" oil 2 gal. + Wyo. bent. 1 lb.	28	2	8
4	Para. 1 lb. + S 6 lb. Calyx spray only	84	-	-
5	Para. 1 lb. + S 6 lb. 1st cover only	234	-	-
6	Shell Helix "Superior" oil 3 gal. + Wyo. bent. 1.5 lb.	-	3	-
7	Shell Helix "Superior" oil 2 gal. + Bdx.	-	36	-
8	Shell Helix "Superior" emulsible oil 2 gal.	-	32	-
9	DN-289, 2 qt.	-	-	45
Maximum populations on check plots		3,356	6,084	377

1/ Treatments 1, 2, 3, 6, 7, 8 applied March 16-18. No. 4 applied April 26, No. 5 May 5, and No. 9, March 25.

2/ On six dates between April 16 and June 30.

Summer Sprays

The most promising miticides were tested most extensively in the regular codling moth and leaf roller tests. Special tests with other materials were set up in two series of unreplicated 2-tree plots after mite infestations had built up to high levels.

T. bimaculatus: To 14 Golden Delicious plots where the combined numbers of mites and eggs (mostly T. bimaculatus) ranged from 67 to 258 per leaf on August 3, sprays containing DDT or DDT and a miticide were applied August 7. Population counts were made August 9 and 21. Average percent reductions in mites ranged from 99.2 down to 55 percent. The spray materials tested follow in the order of their effectiveness: DN-111 (1.25 pound), Neotran (2 pound), Naug. 83-N (1 pint), Para. (2 ounces), Check (no miticide added to the DDT), toxaphene (3 pound), Dimite (1 pint), Para. (4 ounces), MEP (3 pound), Velsicol 104 (2 pound), IN-4200 (1 pint), Rhothane (1 quart), CR-1639 (1 quart), and Azobenzene (3 pound).

In this experiment the check plot was located at one corner of the area and was bounded on the east and north by plots in another series sprayed on August 5 with DDT and parathion, the latter at 1 pound per 100 gallons. After that application the wind blew from the north, northeast or east and as a result the number of mites and eggs on the check plot declined from 4,720 and 15,264 (per 100 leaves) respectively on August 3 to only 9 mites and 6,320 eggs on August 9. No other plot, with the possible exception of that receiving Neotran was within range of the fumigating action of parathion.

P. pilosus: Twenty treatments (4 in duplicate) were applied to Ben Davis trees on which the average red mite population on June 30 was 42 mites and 17 eggs per leaf. They had been sprayed 7 times with DDT by the grower. Rainy weather intervened before the first miticide application could be made on July 6 and the mite populations had declined to an average of 8 per leaf. The combined egg and mite populations ranged from 3 to 24 per leaf on the various plots. A second application was made to each plot July 19. The numbers of mites present on July 12, 19, 22, August 6 and 24 were compared with the initial populations in evaluating the treatments. Materials, which when used with DDT maintained average reductions of 95 percent or better included Dimite (0.5 and 1 pint), toxaphene (6 pound), CR-1639 emulsion (1 quart), CR-1639 wettable (2 pounds) on 2 plots, Neotran (2.5 pounds), on 2 plots and parathion (0.5 pound) on 2 plots. Those maintaining average reductions of 90 to 95 percent were summer oil (3 quarts), Dimite (1 pint), toxaphene (3 pounds), DN-111 (1.25 pound), IN-4200 (1 pint), azobenzene (2 pounds), and MEP (3 pounds). Reductions of 80 to 90 percent were effected by TEPP (4 ounces), L-48 (2 pound), azobenzene (4 pounds) and parathion (2 ounces). TEPP (2 ounces) and DDT-50 (2 pounds) used alone, showed reductions of 32 and 56 percent respectively while DDT-50 (4 pounds) produced a slight average increase.

Miticide Dusts

Plots of 20 trees each, having mite and egg populations of from 28 to 35 per leaf were dusted August 9. Each dust contained 10 percent DDT in addition to the miticide. As in 1947 better results (90 percent reduction in 3 days and 87 percent average reduction to September 20) were obtained with a freshly mixed walnut shell flour dust containing 2.5 percent of TEPP (40%) than with 1 percent parathion. An azobenzene (4%) dust gave an average reduction of only 20 percent.

Fumigating Effect of Parathion on Mites

The possibility that parathion sprays might be effective in killing insects in nearby unsprayed trees was first suggested by results obtained in 1947. A heavy knockdown of Chrysopid larvae from trees adjacent to those sprayed with parathion was noted within 48 hours after the parathion spray. Its fumigating action on codling moth larvae and circumstantial evidence of its fumigating action on mites have been discussed elsewhere in this report. In addition, foliage heavily infested with mites was placed in water-filled jars and suspended in trees sprayed with non-parathion treatments several hours after parathion sprays were applied on nearby trees. Within 24 hours, foliage suspended in trees 40 ft. to the lee-ward of those sprayed with parathion contained few active and many dead mites whereas no mortality was observed in trees on the lee-side of those not sprayed with parathion.

On June 26 a square block of 36 trees set 40 x 40 feet was sprayed with a suspension of 4 pounds 25 percent parathion per 100 gallons at the rate of 2 to 2.5 gallons per tree using a Buffalo Turbine. The amount of parathion used per tree was the equivalent of 0.25 pound per 100 gallons applied with conventional equipment. The results follow:

Location	Mites per 100 leaves June 26	Percent change June 28	Percent change June 30
Grimes, Golden Delicious and Starking			
Across center of treated area	2,840	-99	-80
First outside row across northeast side	2,424	-65	-33
Second " " " " "	3,632	-45	+ 3
First " " " southwest "	3,088	-86	-59
Second " " " " "	2,928	- 1	- 2
Grimes only			
First " " " southeast "	6,416	-87	-78
Second " " " " "	2,040	+29	-75
Golden Delicious only			
First outside row across northwest side	1,240	+27	-73
Second " " " " "	1,304	+57	-71

The population counts were made on the side of each row farthest from the treated area. Some fumigating effect extended 80 feet to the second row on the southeast, northeast, and northwest (after the wind shifted to the east) but only to the first row on the southwest. Wind velocity was 1.5 mph from the southwest at the time of application. During the next 4 days its direction was variable though generally from the southwest during the day. Extremely quiet conditions prevailed early on the morning of June 27, 29 and 30. Showers were frequent, the rainfall totalling 1.34 inches between June 26 and 30. The delayed action on the west side is believed to have resulted from the shifting wind.

These results raise the question of what effect parathion might have on persons living in or adjacent to large orchards sprayed with concentrations of 4 ounces or more per 100 gallons. Three families lived immediately adjacent to two of our 7-or 8-acre experimental blocks in which half the trees were sprayed several times with from 4 ounces to 2 pounds per 100 gallons. No ill effects were reported.

Surveys of Mite Populations in 26 Commercial Orchards

In west central Tennessee average populations of both red mites and spider mites have increased during each of the 3 years DDT has been used. In western Kentucky red mites were absent in 1946 but are now present in all orchards. In this area spider mites have not increased. In southwestern Indiana red mites have increased very little since 1946 but spider mites increased greatly in 1948. In northern Indiana there was very little change during the 3-year period. The greatest increase in either species usually occurred during the first years use of DDT, however, growers used more effective control measures in each succeeding year and local variations in climatic conditions have had a very important influence on comparative mite abundance. There appeared to be no correlation between mite abundance in September and that found on the same trees the following June. As a rule the Delicious varieties have supported the largest populations.

In 1948 the maximum red mite infestation of 205 mites per leaf was found in June in a west central Indiana orchard from which the dormant spray was omitted. Spider mite infestations were found ranging up to 127 per leaf in July, 166 in August and 101 in September. The average infestation for the period from June to September in the 24 orchards sprayed with DDT was 15 mites per leaf (based on 12 samples of 100 leaves per orchard). Three genera of predaceous mites were found. These were Mediolata sp., Pronematus sp., and Iphidulus sp. The maximum numbers brushed from a single 100-leaf sample was 122. In an unsprayed orchard early in June these mites outnumbered phytophagous mites.

Red-Banded Leaf Roller Control

In Commercial Orchards

In northern Indiana an outbreak of this pest affecting 85 percent of the crop on some varieties occurred in an orchard where in 1947, injury on the same trees was only 0.3 percent. Conditions leading to this outbreak were, except for weather and climate, similar to those which characterized the initial Vincennes outbreak in 1946 (20 to 65 percent loss on 265 acres) and that at Paducah, Kentucky (50 percent loss on 100 acres) in 1947. These were (a) proximity of the center of infestation in apples to a fair sized planting of other host plants rarely if ever sprayed (b) use of DDT with or without lead arsenate for one or more years prior to the year of the outbreak (c) use of DDT without lead arsenate (or Rhothane or parathion) after the petal fall or first cover spray. A fourth and the most important factor was undoubtedly the inability of the parasites at the source of the infestation to reproduce in the DDT sprayed trees. Leaf roller populations are now present in all except one of the 26 orchards surveyed, and are at a potentially dangerous level in two-thirds of the orchards.

On Foliage

Because of interplot migration of moths the full benefits of early season control could not be shown in small plot tests in which replicates up to 0.4 acre in size were used. Examinations of several hundred leaves or terminals per plot after first-brood hatch demonstrated the superiority of parathion to lead arsenate + DDT for the control of this brood.

In 3 separate series of plots the use of 1 pound or more parathion (25%) per 100 gallons in the first cover spray gave complete control compared to populations of 17 larvae per 1,000 leaves, and from 26 to 98 per 1,000 terminals where 4 pounds lead arsenate was used. One pound of parathion substituted for lead arsenate + DDT in the calyx or second cover failed to give complete control. Hatch was either complete or pupation had started. However, 2 pounds in the second cover was sufficient to kill all larvae and pupae on the trees. At harvest on 0.4 acre replicates where complete or nearly complete first-brood control was obtained by substituting parathion for lead arsenate, 12.5 to 14.1 percent of the fruit was injured. Where the substitution was not made injury at harvest was 8.1 percent. All plots were sprayed alike except for the differences stated.

In special spray tests on Duchess late in August lead arsenate (4 pounds) killed only 4 percent of the larvae within 24 hours compared to 25 percent for DDT-50 (2 pounds) and 54 percent for parathion (1 pound). The 25 percent Rhothane emulsion at 1 quart per 100 gallons drove many larvae from the foliage and mortality data could not be obtained. During the period from 4 to 25 days after the sprays DDT residues effected no control but the lead arsenate, parathion and Rhothane treatments each reduced the infestation 93 to 95 percent below that on trees sprayed with DDT. At 1 pint per 100 gallons Rhothane gave about 85 percent control.

Conclusion

The results recorded herein indicate that after more information is obtained concerning the best methods of combining the materials discussed we can doubtless dispense with dormant and summer oil sprays and with lead arsenate, at least in most orchards of the Middle West.

BELTSVILLE, MARYLAND

E. H. Siegler, In Charge

Laboratory Experiments with Insecticides for Codling Moth

A few laboratory tests were made by means of the apple-plug method of pure DDT and of the pure bromine and fluorine analogues of DDT against newly hatched codling moth larvae, using Rome and York apples. The data obtained indicate that neither of these analogues was as effective as DDT.

Compound and Concentration Pounds/Gallons in 20% Ethanol		No. of Tests	No. of Apple Plugs	Percentage of Plugs	
				Wormy	Stung
DDT	1/2-100	3	307	15	26
Bromine analogue	1/2-100	3	293	33	33
Fluorine analogue	1/2-100	3	289	73	4
DDT	4-100	2	206	0	0
Bromine analogue	4-100	2	212	5	2
Fluorine analogue	4-100	2	211	1	1
Check		3	309	94	0

A single test of parathion (25% wettable), at a concentration of 1/4 pound per 100 gallons of 20 percent ethanol, killed all larvae but permitted 56 percent of stung apple plugs.

Ultrasonic Effects on Codling Moth

Experiments were conducted during the year to determine what effects ultrasonics might have upon newly hatched codling moth larvae and eggs under laboratory conditions. A high-intensity piezoelectric generator, equipped with a quartz crystal in which the vibrations originated, was used. The sound radiations were above the normal audible limit.

The detailed results will not be given, but in summarization it may be stated that naked larvae were killed on exposure to the radiations, the percentages of mortality varying with tests conducted on two days. Approximately 10 larvae were used per test. In one series the mortality ranged from 25 percent for a 10-second exposure to 100 percent for an exposure of 40 seconds. In the second series of tests, the mortality was 50 percent for an exposure of two seconds to 70 percent for five seconds.

The effect of sound radiations on first-instar larvae feeding within apple plugs was also determined for exposures up to one hour. But one larva was used for the maximum period and this survived.

Ovicide studies with eggs of different ages were made using exposure periods of 15 to 120 seconds. The percentages of unhatched eggs exposed to sound radiations were somewhat higher than were those for the unexposed eggs.

No practical application for the use of sound waves for the destruction of the codling moth is apparent from these tests. The data should be considered as very preliminary; they are offered merely as having some possible fundamental value.

Insecticidal Stability of Parathion Plus Dreft

The insecticidal effectiveness of parathion 1-40,000 plus Dreft 1-10,000 in distilled water was determined from time to time under laboratory conditions by means of the leaf-disk technique. The mixture was tested against several species of aphids--green peach aphid, Myzus persicae (Sulz.), cabbage aphid, Brevicoryne brassicae (L.), bean aphid, Aphis fabae Scop., a green aphid, Rhopalosiphum rufomaculatum (Wils.), and against the two-spotted spider mite, Tetranychus bimaculatus Harvey.

The results obtained after the mixture had aged six months and 14 1/2 months in comparison with Dreft alone are tabulated below.

Tested Against	Percent Mortality			
	6 Months		14 1/2 Months	
	P+D	Dreft	P+D	Dreft
Two-spotted spider mite	100	13	99	5
Green peach aphid	99	3		
Cabbage aphid	98	3	94	0
Bean aphid			79	15
A green aphid			100	8

Insecticidal Stability of Parathion Mixed with Fungicides

To determine the stability of parathion in the presence of alkaline fungicides this compound was mixed with lime-sulfur, bordeaux, and Copper-A; the resulting mixtures were aged in closed jars. All tests were made in the laboratory by means of the leaf-disk technique at irregular periods against several species of aphids--apple aphid, Aphis pomi Deg., green peach aphid, Myzus persicae (Sulz.), cabbage aphid, Brevicoryne brassicae (L.), cotton or melon aphid, Aphis gossypii Glov., a green aphid, Rhopalosiphum rufomaculatum (Wils.), chrysanthemum aphid, Macrosiphoniella sanborni (Gill.), and against the two-spotted spider mite, Tetranychus bimaculatus Harvey.

The mixtures were formulated as given below; all percentages are on the basis of weight.

Parathion 0.0025% + Dreft 0.01%

Parathion 0.0025% + lime-sulfur 2.5% + Dreft 0.01%

Parathion 0.0025% + bordeaux 2% + Dreft 0.01%

Parathion 0.0025% + Copper-A 0.25% + lime 0.5% + Dreft 0.01%

In general it may be said that parathion in the presence of the alkaline fungicides--bordeaux, lime-sulfur, or Copper-A plus lime, gradually loses its effectiveness against several species of aphids and the two-spotted mite (against the latter lime-sulfur in the mixture remains effective). The above-mentioned mixtures continue to serve effectively as insecticides as long as sufficient parathion remains free from chemical reactions.

Studies on Translocation of Parathion

An experiment was set up in the greenhouse for the purpose of studying the possible translocation of parathion from the roots of apple trees to the above-ground portions. One-year budded Red York-King apple trees were potted in sandy soil after which the pots for each plat were held in separate aluminum trays so as not to lose the chemical.

The parathion was mixed with a pint of water and this was poured on the soil of each pot. It was then covered lightly with sand. Four quantities were used - 2, 4, 8, and 16 grains per 8-inch pot. The trees were watered from below through the addition of water to the aluminum trays, except that at intervals 1 pint of water was added to the surface soil to help distribute the parathion.

Observations during a period of several months were taken on the following sucking insects--apple aphid, woolly apple aphid, rosy apple aphid, cotton or melon aphid, a mealy bug, and on the two-spotted spider mite.

No injurious effects of the treatments on the trees were apparent. Sucking insects were apparently unaffected except in the case of some woolly aphids on the trunks of several trees within two inches of the soil. These were killed shortly after the parathion was applied, possibly through fumigation.

In a small test against a chewing insect, the yellow neck caterpillar, Datana ministra Drury, considerable mortality was obtained in the pot containing the highest quantity of parathion. However, there was no proof that the insecticidal action came through translocation; it could have been due to parathion condensate on the surface of the foliage.

POUGHKEEPSIE, NEW YORK[1]/

D. W. Hamilton, U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine, and R. W. Dean, New York Agricultural Experiment Station.

Codling moth injury was of minor importance in commercial orchards in the Hudson River Valley in 1948. Insects and mites that caused the most injury in apple orchards in 1948 in descending order of importance were the two-spotted spider mite, apple maggot and red-banded leaf roller.

Overwintering codling moth larvae began pupating near Poughkeepsie, N. Y. April 9. Adults were first taken in bait traps May 20, and peak captures of spring-brood moths occurred the nights of June 1 and 2. Where DDT was used in summer sprays captures ceased after the first application made about June 14, and did not increase to any extent during the remainder of the season. First-brood larvae began entering the fruit June 12 and peak entrances occurred June 17 to 24. First-brood moths began emerging in the insectary July 21 and began coming to bait traps in orchards between July 25 and 29. Peak captures for first-brood moths occurred between July 28 and August 1. A second peak occurred August 24 to 26 in a few orchards where adequate protection had not been maintained throughout first-brood larval hatch. Temperatures at this time were ideal for codling moth development and most of the injury that was found at harvest occurred during this period.

Drouth conditions existed from August 13 to September 30.

Field Tests of Insecticides

Spray Experiments--E. Stuart Hubbard & Son Orchard, Poughkeepsie, N. Y.

Replicated plots were arranged on mature Cortland trees in this orchard for the purpose of further comparing parathion (25 percent) with DDT (50 percent) for codling moth control and applications with a concentrate mist sprayer, built at this laboratory, with those made with a high pressure hydraulic sprayer. A moderate infestation of red-banded leaf roller developed in this orchard late in the season.

Plots consisted of three trees each, located in single rows, replicated three times, except for treatment 7. Distance between trees in the row was only 20 feet, hence, records were obtained from the center tree only in each replicate. Treatment 7, where mist spray applications were made, was replicated twice on 6 or 7 trees in a row. In this case, two trees near the center of each replicate were selected as record trees.

1/ These investigations were carried on jointly by the U. S. Bureau of Entomology and Plant Quarantine and the New York State Agricultural Experiment Station at the Hudson Valley Fruit Investigations Laboratory, Poughkeepsie, N. Y.

The grower put on all applications made prior to the first codling moth cover spray. All treatments, except treatment 7, were applied with a conventional hydraulic sprayer by operators working from the ground with single-nozzle guns. Micronised wettable sulfur was included in the treatments applied to Plots 1 through 6 in the first four cover sprays. Six pounds of sulfur was used in the first two covers and five pounds in the third and fourth.

Description and pictures of the machine used to apply the concentrate mist to Plot 7 will be found in the Jour. Econ. Ent. 41(2):180-85. Applications of mist sprays were made about 8:00 p.m. when air conditions were nearest ideal for operation of this type of machine. Trees were covered by driving both sides of each plot. Approximately one gallon of spray was applied per tree at each application. Micronised wettable sulfur, 50 pounds to 100 gallons, was included in the first four cover sprays.

Five cover sprays, four applied during the time first-brood larvae were entering the fruit and one during the time second-brood larvae were entering the fruit, were applied to all plots. Dates of applications were June 10, 22, July 2, 15 and August 9. The latter application is believed to have been the most effective one as concerns red-banded leaf roller control.

Insecticides used and data on codling moth and red-banded leaf roller injury are shown in Table 1.

Table 1.--Codling Moth and Red-Banded Leaf Roller Injury, E. Stuart Hubbard & Son Orchard, Poughkeepsie, N. Y., 1948. (Variety Cortland)

Plot	Insecticide (per 100 Gallons)		Codling Moth				Red-Banded Leaf Roller Injury Percent
			Av. No. Apples per Tree	Injury Per-cent	Av. Number per 100 Apples	Av.No. Worms per Tree	
					Worms Stings		
1.	No insecticide		1164	24.7	30.0 5.3	368	23.4
2.	Parathion	10 oz.	1676	4.4	3.8 1.7	66	7.9
3.	Parathion	20 oz.	1302	4.5	3.6 1.7	45	2.4
5.	Parathion DDT	5 oz. 1 lb.	1493	4.5	3.6 1.8	59	9.8
6.	DDT	2 lb.	1766	3.6	2.8 1.6	50	20.7
7.	DDT (Mist)	20 lb.	1742	7.1	6.3 2.8	117	26.6

It is believed that much of the difference in control between the mist and conventional spray applications was due to lack of penetration of the mist through the dense foliage of the trees and lack of coverage in the tops of the trees. Air capacity of the machine used was too small to secure maximum efficiency of mist sprays.

Parathion deformed the leaves on the new growth as a result of the first cover application made June 10. Injured leaves became "goosenecked", a type of injury sometimes caused by lime-sulfur. Severe defoliation followed the first application of 20 or 30 ounces of parathion (25 percent) per 100 gallons. For this reason Plot 4, sprayed with 30 ounces parathion per 100 gallons, was discontinued.

Samples of fruit were taken before and after the fourth and fifth cover sprays and at harvest for analyses of parathion present. Analyses were made by the Division of Insecticide Investigations, Beltsville, Md. with the results shown in Table 2. Additional analyses revealed no parathion present in the flesh of harvested fruit.

Table 2.--Parathion Residue Analyses on Cortland Apples, E. Stuart Hubbard & Son Orchard, Poughkeepsie, N. Y., 1948.

Plot	Insecticide (per 100 Gallons)	Replicate	Parathion PPM				
			4th Cover July 15		5th Cover August 9		Harvest Sept. 28
			Before	After	Before	After	
2.	Parathion (25%) 10 oz.	A	0.11	0.49	0.07	0.77	0.03
		B	0.06	0.42	0.04	0.55	--
		Av.	0.08	0.45	0.05	0.66	0.03
3.	Parathion (25%) 20 oz.	A	0.15	0.69	0.09	1.59	0.05
		B	0.20	0.90	0.10	1.26	--
		Av.	0.17	0.79	0.09	1.42	0.05

Large Scale Grower Experiments with DDT

Two large scale DDT spray experiments conducted by growers were observed for a fourth season. Dormant oil sprays were applied to both orchards. A summary of the treatments used and infestation records covering the four-year period is shown in Tables 3 and 4.

Table 3.--Large Scale DDT Tests, J. R. Clarke & Sons Orchard, Milton, N. Y., 1945-48. (Variety McIntosh)

Summer Schedule (Insecticide per 100 Gallons)

1945 DDT (25%) 4 lb. 5 covers, June 1, 13, 22, July 6, and August 14.
1946 DDT (50%) 2 lb. 4 covers, June 13, 21, July 6 and 19.
1947 DDT (50%) 2 lb., lead arsenate 3 lb. 1 cover, June 9.
DDT (50%) 2 lb. 2 covers, June 26 and July 4.
Hexaethyl tetraphosphate 1 cover, August 28.
1948 DDT (50%) 2 lb. 2 covers, June 15 and 25.
20% lead arsenate dust, 1 cover, June 30.
Parathion (15%) 1/2 lb. 1 cover, August 12.

Year	Av. No. Apples Per Tree	Codling Moth				Red-Banded Leaf Roller	Harvest Residues
		Injury Percent	Average Number Per 100 Apples		Average No. Worm Holes Per Tree	Injury Percent	DDT PPM 1/
			Worms	Stings			
1945	2382	2.4	0.1	2.5	2.8	--	5.0
1946	1528	0.4	0.1	0.4	1.8	--	3.9
1947	5068	0.8	0.1	0.9	8.5	4.7	2.0
1948	2051	0.8	0.1	1.0	2.6	9.2	--

1/ Analyses by U. S. Bureau of Entomology and Plant Quarantine, Division of Insecticide Investigations.

Table 4.--E. Stuart Hubbard & Son Orchard, Poughkeepsie, N. Y., 1945-48. (Varieties--1945-46, McIntosh; 1947-48, Cortland)

Summer Schedule (Insecticide per 100 Gallons)

1945 DDT (25%) 4 lb. 6 covers, June 1, 12, 22, July 1, 30, and August 8.
1946 DDT (50%) 2 lb. 3 covers, June 11, 25, and July 15.
5% DDT dust 1 cover, August 7.
1947 DDT (50%) 2 lb., lead arsenate 3 lb., lime 3 lb. 1 cover, June 9.
DDT (50%) 2 lb. 1 cover, June 23.
5% DDT dust 2 covers, July 9 and August 11.
1948 5% DDT dust 2 covers, June 10 and July 17.
DDT (50%) 2 lb., lead arsenate 3 lb. 3 covers, June 11, 21, and July 7.

Year	Av. No. Apples Per Tree	Codling Moth				Red-Banded Leaf Roller	Harvest Residues
		Injury Percent	Average Number Per 100 Apples		Average No. Worm Holes Per Tree	Injury Percent	DDT PPM 1/
			Worms	Stings			
1945	1943	4.7	1.2	4.7	24.5	--	8.3
1946	5472	1.9	1.2	0.9	64.0	--	3.3
1947	2904	6.9	2.3	6.4	66.7	6.2	1.5
1948	2134	5.1	4.3	2.2	86.0	7.3	--

1/ Analyses by U. S. Bureau of Entomology and Plant Quarantine, Division of Insecticide Investigations.

Codling moth control has not been a serious problem in either of the above orchards since the beginning of the use of DDT, although both orchards suffered severe codling moth injury annually prior to the time this insecticide was first used. The crop in the Clarke orchard was at least 40 percent wormy in 1944 and that in the Hubbard orchard was 80 percent wormy.

The two-spotted spider mite, Tetranychus sp., was first observed infesting apple in the Clarke orchard in September 1945. This was following the first use of DDT. Since that year moderate to severe infestations have appeared annually in August and September. These infestations account for the use of hexaethyl tetraphosphate in 1947 and parathion in 1948. The two-spotted mite was observed on apples in the Hubbard orchard as early as 1946 but infestations have not developed in any season to the extent that special sprays have been necessary for their control.

Red-banded leaf roller injury was noticeable in both the Clarke and Hubbard orchards in 1947 and 1948 and it increased in the Clarke orchard in 1948. However, red-banded leaf roller injury is still comparatively low in both orchards.

Residues of DDT present on fruit at harvest have been below 7 p.p.m. in all cases, Tables 3 and 4, except in the Hubbard orchard in 1945 (1948 analyses are not yet available). Composite samples of soil from underneath trees in the Clarke orchard that had been sprayed with DDT for three seasons were prepared from the top 2 1/2 inches in October 1947 and analyzed for DDT content by the Division of Insecticide Investigations, Beltsville, Md. Analyses showed 69.6 p.p.m. of DDT.

Five codling moth bait traps have been operated in the same locations in each of the above orchards for the past four years. Average annual moth captures per trap were as follows: Clarke orchard, 1945 - 266, 1946 - 25, 1947 - 8, 1948 - 12; Hubbard orchard, 1945 - 264, 1946 - 47, 1947 - 37, 1948 - 39.

YAKIMA, WASHINGTON

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Seasonal Conditions and Pest Development

In contrast to 1947, which was an early season, the spring of 1948 was very late, apples being in bloom May 10, 26 days later than in 1947 and 14 days later than normal. Rainfall in May and June totaled almost five inches, the highest recorded for those two months since Weather Bureau records were started in 1890. After June, the weather was about normal.

Owing to the late, wet spring there was little codling moth activity before June 10 and not very much before July. Pacific mites began migrating into the trees about mid-April, and oviposition began about April 20. The wintering European red mite eggs were hatching from April 26 to May 12, and the first summer eggs were deposited May 20.

Spray Materials Used

BHC	Benzene hexachloride, 12% gamma.	K-1875	Bis(p-chlorophenoxy) methane. 40% wettable.
DDT	50% wettable.	Lime sulfur	32° Baume'
DMC	1,1-bis(p-chlorophenyl) ethanol. 25% emulsible.	Summer oil	100% active ingredients.
Dorm. Oil	83% active ingredients.	Para.	Parathion. 25% wettable powder.
IN-4200	Lorol-2-thiazolinyl sulfide. 75% active.	Tox.	Toxaphene. 50% water miscible.

Codling Moth

Most of the 38 tests made in two orchards were intended for mite and woolly aphid control. Seven tests in each orchard, however, were used for getting information on the control of the codling moth, all of them being variations in the use of DDT. These orchards were the same ones used in 1947, one of them including Winesaps and the other one Delicious. For the codling moth, plots of 7 or 8 trees were used, distributed at random in the orchard, and samples of 250 apples per tree were examined at harvest.

No calyx spray was applied. In the Winesap orchard four cover sprays were applied, although in some plots only three covers were used. The dates of these applications were June 1-2, June 22-23, July 13-14, and August 5. In the Delicious orchard, which had been less wormy than the Winesap one, two cover sprays were applied for the codling moth, June 15-16, and July 6-8. Plot 10 had only the first of these. Some of the plots were sprayed a third time, on July 29-30, for mites only, no DDT being used.

The results of the tests are given in Table 1. The season was one of the latest we have had, but in spite of this it took four applications of DDT in the Winesap orchard for fair control, and in the Delicious orchard, in which the first spray was delayed until most of the first brood of European red mite eggs had hatched, two applications were hardly enough. In orchard A, Winesap, it is evident that less than four applications (Plots 4, 9 and 10) resulted in more wormy fruit while in orchard B

(Delicious) reduction in the number of applications from two to one resulted in more wormy fruit. The data do not indicate clearly the extent of the effect of parathion and toxaphene, as used, on codling moth control. In our 1947 tests toxaphene appeared to have some effect.

Trees in the Delicious orchard sprayed twice by the owner with a Bean Speed sprayer had the same infestation as trees sprayed twice by us with spray guns on about the same dates and with the same concentration of DDT. The infestation in both cases was about 2.7 percent wormy. Trees sprayed three times with the Speed Sprayer had only 0.5 percent wormy fruit.

Relation of Spray Treatment and Blooming Dates to Size of Winesaps: The same Winesap orchard has been used for four years for tests of DDT and other materials. The table below shows the average size of the apples, average number of apples per tree and date of full bloom in this orchard for the four years:

Year	Date of Full Bloom	Av. No. Apples Per Tree	Number of Apples Per Box Spray with DDT	Spray with No DDT
1945	May 2	2150	148	145
1946	Apr. 26	1650	116	115
1947	Apr. 14	2750	119	123
1948	May 10	2210	158	-
Av. 1945-47		--	119	119.5

There is no apparent effect of DDT on the size. There appears to be more correlation of size with date of full bloom than with anything else.

Mites

Trunk Sprays for Pacific Mites: On March 16, five materials were sprayed on the trunks and lower limbs of apple trees to determine what control of the Pacific mite might be obtained. These were as follows: emulsified stove oil, 10 percent; lime sulfur, 11 percent; DMC 1 and 1-1/2 pints to 100 gallons; parathion (15 percent) 1/2 and 1 pound; toxaphene 1 and 1-1/2 pints. Late in March small lots of trash from the bases of the trees were put in battery jars in a warm room and the mites crawling up the sides were counted. On June 1, 20 leaves from the lower center of each tree where the infestation would be heaviest were collected. There were four trees in each plot and mites were counted on the composite sample of 80 leaves from each plot.

It appeared from these tests that DMC had no value as a trunk spray, as the trash sprayed with it produced almost as many mites as the check and in June there were 40 to 60 mites per leaf as compared with 44 on the check. The other materials all effected some control, live mites from the trash being comparatively few, and the numbers on the leaves June 1 being considerably lower than on the check. However, there were from 12 to 30 mites per leaf in June and it may be questioned whether this reduction is enough to make a special trunk spray worth while.

Dormant and pink sprays for European red mite were tested as shown in Table 1A. Parathion, DMC, K-1875 and IN-4200, as used, all kept the infestation low until the end of July. Lime-sulfur, in pink and calyx, (Plot 4) did the same. The other applications were less effective. All plots were sprayed with DDT on June 18 and July 8. Plots 1, 2, 3, 8 and 10 were sprayed July 30 with DMC or tetraethyl pyrophosphate which prevented infestations from developing that would cause any injury. The other plots were not sprayed with any acaricide during the summer and none of them developed infestations of more than 10 or 15 mites per leaf and this only for a short time in August. The lowest infestations were in Plots 4, with a maximum of 7 per leaf, 5, with 8 per leaf, and 6 and 7, with 10 per leaf. In none of these plots was any effect on the size and color of the fruit noted. It would seem that a pink and calyx spray of lime-sulfur, as used for mildew, would control the mites at least until late/July. It may be questioned whether it would pay to use the other materials in the pink application.

Pacific Mite

Some of the summer tests for the control of the Pacific mite are shown in Table 2, Winesap orchard. While differences in control are evident, in no case was there any failure to control to the point where the size and color of the fruit were affected. Parathion seemed to be about the best all around material. Comparing the other materials with it, two or three sprays of DMC were as good as two or three of parathion. One spray did not compare quite as well. Toxaphene compared very well with parathion when three applications were used but was not as lasting. IN-4200 controlled well but had even less residual effect than toxaphene. K-1875 did not control as well as DMC, parathion or toxaphene. It produced russeted spots on about 25 percent of the apples and there was no difference in this regard between 1947 and 1948 material.

European Red Mite

Some of the summer tests for the control of the European red mite are shown in Table 2, Delicious orchard. Here again there is no evidence of any mite injury in any of the plots. Again comparing the other materials with parathion, DMC was definitely inferior. Even where three sprays were put on it showed evidence of less residual value. Toxaphene was, if anything, a little more effective than DMC, but less effective than parathion. IN-4200 and K-1875 were both equal to parathion for controlling this mite, but again the K-1875 russeted about 25 percent of the apples.

Comparative Value of Acaricides for Controlling Pacific and European Red Mites

The Winesap orchard was used originally for tests against the Pacific mite. By August an infestation of the European red mite had developed in this orchard, although this species had not been evident here during the three previous seasons, and comparative results on the two species could be obtained by counting the numbers of both species present on the same leaves. The data indicate that DMC controls the Pacific mite better than the European red mite but that there is very little difference in the degree of control of the two species by parathion. Toxaphene also controls the Pacific mite better than it does the European red mite. On the other hand, both IN-4200 and K-1875 control the European red mite much better than they do the Pacific mite.

Very limited tests of azobenzene, benzyl phenyl nitrosoamine, 2,4-dinitrophenol, p-nitro benzoic acid iso propyl ester and dinitro capryl phenyl crotonate (CR-1639) indicated that only the last named showed much promise as an acaricide.

WOOLLY APPLE APHID

The spray schedule used for tests against the codling moth and mites was also used for tests against the woolly apple aphid. Plots used for this purpose are shown in Tables 3 and 4.

DMC (Plots 1 to 6). There is no evidence that DMC had any effect on the woolly aphid.

Parathion (Plots 7 to 12). There is definite evidence of an effect on the aphids. At the dilutions used it is apparently necessary to spray late in July or in August to prevent a heavy build-up of aphids.

Toxaphene (Plots 13 to 15). This material controls woolly aphids quite well, as was noted in 1947.

IN-4200 (Plots 16, 17). There is no evidence that this material had any effect on the woolly aphid.

K-1875 (not shown in tables). This material did have some effect, but not as much as parathion or toxaphene, and since it russeted the fruit it cannot be used in its present condition.

BHC (Plots 1, 3, 4, 6, 9, 10, 12, 14, 15, 17). In 1947 a single application of 4 pounds of 6 percent gamma in May was enough to control the aphids for the season, the infestation in September being only 15 percent of the nodes. Where more than one spray was used, it was even less. There was also some indication that the addition of oil might help. In 1948, one and two early applications were tried at 1 pound of 12 percent gamma, with and without oil. In Plots 1 to 6, where no later spraying was done that would control aphids, better control was obtained in both orchards

where the oil was omitted. Two applications were somewhat better than one. Results from the use of BHC followed by parathion were about the same as where parathion was used throughout the season (Table 3, Plots 11 and 12; Table 4, Plots 7 and 10). The same thing was true of toxaphene (Table 3, Plots 13 and 14). A single application of BHC at 2 pounds might be at least as good as two at 1 pound.

Spray Deposits

Analyses of spray residue deposits were made before and after each cover spray. The analyses were confined, this season, to DDT and parathion. Samples for analysis consisted of 25 discs cut from the same number of leaves collected at random from all parts of each tree sampled, or of 25 apples clipped from each tree. During the early part of the season leaf discs were used exclusively. After the last cover spray, however, apple samples were also taken to determine whether deposits on leaves and apples were approximately the same.

DDT was determined by the colorimetric method of Stiff and Castillo as modified by the Food and Drug Administration. This method has proved reliable for the determination of DDT under the conditions encountered at the Yakima station. Parathion was determined by the colorimetric method developed by the American Cyanamid Company. Benzene was used as the solvent for stripping both DDT and parathion from leaves and fruit.

The average DDT residues are shown in Table 5. Parathion spray residues for each time of sampling are given in Table 6. Samples from some of the parathion-sprayed plots were collected at frequent intervals after spraying to determine the rate of loss of this material. The results of these analyses have been included in the table.

Table 1.--Comparative efficiency of insecticides used in large field spraying experiments for the codling moth. Yakima, Washington, 1948

No.	Treatment (Quantities are for 100 Gallons)	No. Sprays DDT	No. Trees	Percent Wormy	Percent Injured
	Orchard A, Winesaps				
1	DDT 1 lb.[1] (1st cov.); 1/2 lb. (2nd, 3rd & 4th cov.), + DMC 1 pt. (3rd & 4th covers)	4	7	2.7	12.5
4	DDT 1 lb. (1st cov.); 1/2 lb. (2nd cov.); 1 lb. (3rd cov.) + DMC 1 pt. (3rd cov.)	3	7	3.9	12.2
9	DDT 1 lb. (1st cov.); 1/2 lb. (2nd & 3rd cov.) + parathion 5 oz.[2] (3rd cov.)	3	7	4.7	12.3
10	DDT 1 lb. (1st cov.); 1/2 lb. (2nd cov.); parathion 5 oz. (3rd & 4th cov.)	2	7	5.2	16.6
11-12	DDT 1 lb. (1st cov.); 1/2 lb. (2nd, 3rd & 4th cov.) + parathion 2.5 oz.[3] (3rd & 4th cov.)	4	7	3.6	12.7
13	DDT 1 lb. (1st cov.); 1/2 lb. (2nd, 3rd & 4th cov.) + toxaphene 1 pt. (4 cov.)	4	6	3.2	9.9
	Orchard B, Delicious				
1	DDT 1 lb.[1] (1st cov.); 1/2 lb. + DMC 1 pt. (2nd cov.); DMC 1 pt. (3rd cov.)	2	5	3.4	4.4
4	DDT 1 lb. (2 cov.) + DMC 1 pt (2nd cov.)	2	8	2.4	4.1
9	DDT 1 lb. (1st cov.); 1/2 lb. + parathion 5 oz.[2] (2nd cov.)	2	8	2.7	4.3
10	DDT 1 lb. (1st cov.); parathion 5 oz. (2nd and 3rd cov.)	1	8	4.4	5.9
11-12	DDT 1 lb. (1st cov.); 1/2 lb. + parathion 2.5 oz.[3] (2nd cov.); parathion 2.5 oz. (3rd cov.)	2	8	3.0	5.0
13	DDT 1 lb. (1st cov.); 1/2 lb. (2nd cov.) + toxaphene 1 pt. (3 covers)	2	7	1.4	3.2

1/ Actual DDT.

2/ Equivalent to 1/2 pound 15 percent parathion.

3/ Equivalent to 1/4 pound 15 percent parathion.

Table 1A.--Dormant and pink spray applications and European red mite control. Yakima, Washington, 1948

Plot	Treatment (Quantities are for 100 Gal.)	Date Sprayed	No. Mites Per 100 Leaves June 9	June 30	July 21
1	Dormant oil 3.2 gal.	Mar. 23[1]	83	140	1473
1A	Dormant oil 3.2 gal. + 12% benzene hexachloride 2 lb.	Mar. 23[1]	121	233	854
2	Dormant oil 2 gal. + lime-sulfur 3 gal.	Mar. 23[1]	74	87	634
3	Lime-sulfur 3 gal.	May 7[2]	116	60	550
4	Lime-sulfur 3 gal. Lime-sulfur 2 gal.	May 7 May 25[3]	46	47	192
5	Parathion (25%) 10 oz.	May 7[2]	7	11	208
6	DMC (25%) 1 pint	May 7[2]	19	59	324
7	K-1875 (40%) 2 lb.	May 7[2]	0	18	229
8	DN-111 1/2 lb.	May 7[2]	185	410	1825
9	IN-4200 1 pint	May 7[2]	19	36	142
10	Lime-sulfur 2 gal. + Vis-Ko D-24 1 pt.	May 7[2]	10	40	470
11	Check	--	896	--	--

1/ Dormant

2/ Pink

3/ Calyx

Table 2.--Average number mites per leaf[1] and size and percentage of extra fancy apples in plots sprayed for codling moth and mites. Yakima, Washington, 1948.

No.	Treatment (Quantities are for 100 Gallons)	No. Mite Sprays	Av. No. Mites Per Leaf [1]	Size of Apples (Av.No. per orchard Box)	Percent Extra Fancy Apples [2]
	Orchard A, Winesaps				
1	DDT 1#[3] (1st cov.); 1/2# (2nd, 3rd & 4th cov.), + DMC 1 pt. (3rd & 4th cov.)	2	3	159	56
4	DDT 1# (1st cov.); 1/2# (2nd cov.); 1# (3rd cov.), + DMC 1 pt. (3rd cov.)	1	5	151	66
9	DDT 1# (1st cov.); 1/2# (2nd & 3rd cov.) + parathion 5 oz.[4] (3rd cov.)	1	4	162	58
10	DDT 1# (1st cov.); 1/2 # (2nd cov.); parathion 5 oz. (3rd & 4th cov.)	2	1	156	55
11-12	DDT 1# (1st cov.); 1/2# (2nd, 3rd & 4th cov.) + parathion 2.5 oz.[5] (3rd and 4th cov.)	2	2	161	62
13	DDT 1# (1st cov.); 1/2# (2nd, 3rd & 4th cov.) + toxaphene 1 pt. (4 cov.)	4	7	154	58
	Orchard B, Delicious				
1	DDT 1#[3] (1st cov.); 1/2# + DMC 1 pt. (2nd cov.); DMC 1 pt. (3rd cov.)	2	8	97	70
4	DDT 1# (2 cov.) + DMC 1 pt. (2nd cov.)	1	12	92	71
9	DDT 1# (1st cov.); 1/2# + parathion 5 oz.[4] (2nd cov.)	1	8	96	71
10	DDT 1# (1st cov.); parathion 5 oz. (2nd & 3rd cov.)	2	4	95	66
11-12	DDT 1# (1st cov.); 1/2# + parathion 2.5 oz. [5] (2nd cov.); parathion 2.5 oz. (3rd cov.)	2	7	100	68
13	DDT 1# (1st cov.); 1/2# (2nd cov.) + toxaphene 1 pt. (3 covers)	3	12	90	66

[1] During last month of mite counting.
[2] Based on color only.
[3] Actual DDT.
[4] Equivalent to 1/2 pound 15 percent parathion.
[5] Equivalent to 1/4 pound 15 percent parathion.

Table 3.--Woolly aphid infestation in Winesap orchard, Yakima, Washington, 1948

Plot	Treatment (Quantities are for 100 Gallons)				Degree Aphid Infestation	Percent Nodes Infested 4/
	June 1-2	June 22-23	July 13-14	August 5	July 14	Sept. 28
1	DDT 1#1/	DDT 1/2#, BHC 1#	DDT 1/2#, DMC 1 pt.	DDT 1/2#, DMC 1 pt.	0.1	35.4
3	DDT 1#, BHC 1#, oil 2 qt.	DDT 1/2#, BHC 1#, oil 2 qt.	DDT 1#, DMC 1 pt.	--	0	24.5
4	DDT 1#, BHC 1#	DDT 1/2#, BHC 1#	DDT 1#, DMC 1 pt.	--	0.1	16.7
6	DDT 1#, BHC 1#, oil 2 qt.	DDT 1/2#	DDT 1#, DMC 1 1/2 pt.	--	0	34.3
7	DDT 1#	DDT 1/2#, para. 5 oz.2/	DDT 1/2#, para. 5 oz.	DDT 1/2#, para. 5 oz.	0	4.8
8	DDT 1#	DDT 1/2#, para. 5 oz.2/	DDT 1/2#, para. 5 oz.	--	0.1	29.4
11	DDT 1#	DDT 1/2#, para 2 1/2 oz.3/	DDT 1/2#, para. 2 1/2 oz.	DDT 1/2#, para. 2 1/2 oz.	0.3	5.0
12	DDT 1#	DDT 1/2#, BHC 1#, oil 2 qt.	Do	Do	--	2.8
13	DDT 1#, tox. 1 pt.	DDT 1/2#, tox. 1 pt.	DDT 1/2#, tox. 1 pt.	DDT 1/2#, tox. 1 pt.	0	4.0
14	DDT 1#, BHC 1# oil 2 qt.	DDT 1/2#, tox. 1 pt.	Do	Do	--	0.0
15	Do	DDT 1/2#, tox. 1 1/2 pt.	DDT 1/2#, tox. 1 1/2 pt.	--	0	7.3
Check	DDT 1#	DDT 1/2#	DDT 1/2#	--	--	72.7

1/ Actual DDT.
2/ Equivalent to 1/2 pound 15 percent wettable.
3/ Equivalent to 1/4 pound 15 percent wettable.
4/ 100 nodes per tree examined.

Table 4.--Woolly aphid infestation in Delicious orchard, Yakima, Washington, 1948

Plot	Treatment (Quantities are for 100 Gallons)			Degree Aphid Infestation	Percent Nodes Infested 4/
	June 15-18	July 6-8	July 29	July 13	Sept. 29
1	DDT 1#1/, BHC 1#	DDT 1/2#, DMC 1 pt.	DMC 1 pt.	0	24.9
3	DDT 1#, BHC 1#, oil 2 qt.	DDT 1#, DMC 1 pt.	DMC 1 pt.	0	36.0
7	DDT 1#, para. 5 oz.2/	DDT 1/2#, para. 5 oz.	Para. 5 oz.	0.3	17.3
9	DDT 1#, BHC 1#, oil 2 qt.	DDT 1/2#, para. 5 oz.	--	0	28.9
10	DDT 1#, BHC 1#, oil 2 qt.	Para. 5 oz.	Para. 5 oz.	--	18.4
12	DDT 1#, BHC 1#, oil 2 qt.	DDT 1/2#, para. 2 1/2 oz.3/	Para. 2 1/2 oz.	0	15.0
13	DDT 1#, tox. 1 pt.	DDT 1/2#, tox. 1 pt.	Tox. 1 pt.	0.1	14.8
15	DDT 1#, BHC 1#, oil 2 qt.	DDT 1/2#, tox. 1 1/2 pt.	--	0	35.5
16	DDT 1#, IN-4200 1 pt.	DDT 1/2#, IN-4200 1 pt.	IN-4200 1 pt.	0.3	59.3
17	DDT 1#, BHC 1#, oil 2 qt.	DDT 1/2#, IN-4200 1 pt.	--	0	34.5
Check	DDT 1#	DDT 1/2#	--	--	73.0

1/ Actual DDT.
2/ Equivalent to 1/2 pound 15 percent wettable.
3/ Equivalent to 1/4 pound 15 percent wettable.
4/ 100 nodes per tree examined.

Table 5.--Average DDT spray residue deposits in micrograms per square centimeter of leaf surface and residue at harvest in parts per million of fruit. Yakima, Washington, 1948.

Treatment Number	Winesap			Delicious		
	Before Spray	After Spray	Harvest	Before Spray	After Spray	Harvest
	mmg/cm^2		ppm	mmg/cm^2		ppm
1	3.1	9.3	-	1.5	3.5	-
2	2.9	6.4	-	-	-	-
7	3.1	7.6	2.7	2.2	7.7	1.1
10	-	-	-	2.7	7.7	1.5
11	3.2	6.6	-	2.4	9.3	1.6
12	-	-	-	3.5	6.9	1.9
18	1.8	6.2	-	1.6	3.6	-

Table 6.--Parathion spray residues in micrograms per square centimeter of leaf surface and residue at harvest in parts per million of fruit.

Delicious Orchard

Date Sprayed	Date Sampled	Kind of Sample	Residue in mmg per square cm, Plot Number 7	9	10	11	12
6/18	7/1	Leaf	0.11			0.08	
	7/7	Leaf	0.07			0.06	
7/7	7/7	Leaf	0.74	0.73	0.67	0.47	
	7/9	Leaf	0.54	0.49	0.51	0.35	
	7/12	Leaf	0.29	0.27			
	7/14	Leaf	0.26	0.20	0.24	0.21	
	7/16	Leaf	0.24	0.21	0.22	0.19	
	7/28	Leaf	0.04		0.02	0.00	0.00
7/29	7/29 a.m.	Leaf	0.60		0.55	0.40	0.35
		Apple	0.90	0.90	0.40	0.30	
	7/29 p.m.	Leaf	0.50		0.40	0.30	
	7/30	Leaf	0.35		0.37	0.30	0.25
	8/2	Leaf	0.14		0.14	0.09	0.06
	8/4	Leaf	0.12		0.11	0.09	0.07
	8/9	Leaf	0.07		0.09	0.10	0.05
	8/11	Leaf	0.15		0.13	0.09	0.09
	8/16	Leaf	0.07		0.10	0.05	0.07
		Apple	0.09		0.05		
	Harvest	Apple	0.00			0.00	

Winesap Orchard

Date Sprayed	Date Sampled	Kind of Sample	Plot Number 7	8	9	11
6/22	7/1	Leaf	0.17			0.10
	7/12	Leaf	0.03			0.02
7/13	7/13	Leaf	0.64	0.75		
	7/14	Leaf		0.39	0.38	0.34
	7/15	Leaf	0.36	0.37	0.36	0.31
	7/16	Leaf	0.40	0.34	0.30	0.29
	7/19	Leaf	0.21	0.23	0.16	0.14
	7/21	Leaf	0.18	0.15	0.12	0.11
	8/3	Leaf	0.02			0.01
		Apple	0.07			0.06
8/5	8/5	Leaf	0.40			0.25
		Apple	1.10			0.90
	8/6	Leaf	0.33			0.18
	8/9	Leaf	0.16			0.12
	8/11	Leaf	0.15			0.13
		Apple	0.36			0.24
	8/13	Leaf	0.15			0.13
	8/17	Leaf	0.07			0.08
		Apple	0.10			0.03
	Harvest	Apple	0.00			0.00

YAKIMA, WASHINGTON

Division of Control Investigations

R. W. Burrell, In Charge

Scope of Investigations

Studies this season were largely concerned with work on the effects of DDT and other insecticides on host and predator mite population levels and on the effectiveness of various predators in controlling host populations. Data were secured in part from the experimental spray programs put on by the Division of Fruit Insect Investigations and in part from regular weekly surveys in selected commercial orchards.

Effect of Climatic Conditions

The advent of spring was very late this year. Mean temperatures during the summer were not much below normal but there were very few days of extreme heat. The season seemed much less favorable for mite development than the previous one. In part of one commercial orchard where DDT and acaricides have been applied the past two seasons the figures are illustrative. Mite population levels rose from a per leaf average of 0.4 (all stages) soon after the final spray to a high of 2.9 before tapering off. Corresponding figures for 1947 show a low of almost zero from which the population attained a high of 27.5 forms per leaf before the end of the season. Similar, though less extreme, figures were obtained from other blocks and other orchards. Populations of the predaceous mite, Iphidulus, were appreciably less this season. In two comparable orchards the high figures for 1947, expressed as average per leaf, were 1.16 and 1.54. The corresponding figures for 1948 were 0.02 and 0.76. In the first orchard this could have been the effect of a considerably lower host population in 1948, but for the other the difference in host population levels for the two years is not a valid answer.

Effect of DDT

Further evidence has accumulated that the increase of phytophagous mites in orchards sprayed with DDT is due to the adverse effect of the insecticide upon the various predaceous forms. Clear proof of this by means of contrasting population figures is difficult to obtain because at least one and usually most of the applications of DDT are accompanied by some acaricidal material. On one orchard sprayed with cryolite up through 1947 predaceous mites were abundant and apparently responsible for a nearly complete clean-up of the host mite population. This season with a DDT program and despite the adverse season host mites were up to a per leaf population of 19.2 by the end of August and predators were absent the entire season save for a single individual of Stethorus. DDT-sprayed orchards typically

have very few predators except during the early season before insecticide applications and occasionally at the end of the season. The few present are usually of the less effective species, Stethorus.

Effect of BHC

One tree was sprayed with benzene hexachloride for us by the Division of Fruit Insect Investigations for a test of the effect of this material on the predaceous mite Iphidulus. Prior to spraying we had augmented the Iphidulus population by addition of some laboratory reared material. No predators were taken in the first seven weekly surveys after spraying. By the end of the season the predators had recovered sufficiently so that the seasonal host-predator ratio was only half as poor as the average for the cryolite sprayed trees in the orchard.

Control Value of Iphidulus

No data on the effectiveness of Iphidulus in controlling host populations were secured this season. Any possible conclusions to be drawn from data obtained were completely masked by the effects of climate conditions as previously noted. A method for measuring effective abundance of predators by means of the seasonal host-predator ratic has been tried on the survey data accumulated the past two seasons. In 1947 the seasonal ratios in orchards where effective control was apparently due to predators ranged from 16 to 27. The upper limit has not yet been established. This year the best ratio obtained was 59 for some trees in the USDA-experimental block. The figure was even poorer (higher) in two cryolite or lead-arsenate sprayed commercial orchards, but in these the number of host forms per leaf was extremely low.

Host Species Changes

In several orchards sprayed with DDT and a few sprayed with cryolite, the 1947 mite population was almost entirely T. pacificus. P. pilosus was extremely scarce. In 1948 the situation in these orchards reversed, and P. pilosus was the dominant host species.

Biology of Iphidulus

Limited laboratory studies were conducted in the early spring. Females will deposit up to four eggs per day, and several averaged two per day for their life in the laboratory. Average longevity of some field-collected females was 10 days, but these mites had already overwintered in the adult stage before being brought into the laboratory. A few reared females exceeded that time by only a few days. However two reared males lived 26

and 29 days respectively after becoming adult and neither had completed their life span but were still very active and were lost during a change to fresh foliage and host material. Males are only occasionally secured from the regular survey collections. Several unmated females were maintained in the laboratory to test possible parthenogenesis, but none oviposited. The length of time between egg deposition and hatching is normally two and a fraction days.

KEARNEYSVILLE, WEST VIRGINIA

E. O. Hamstead, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture and Edwin Gould, West Virginia Agricultural Experiment Station.1/

Weather Conditions

Weather conditions during the season were favorable for plant growth. Rainfall was above normal and well distributed. Temperatures were below normal with subfreezing temperatures during the early season which resulted in almost complete loss of the cherry crop and heavy reduction in the apple crop, but without commercial damage to the peach crop. Warm periods during February and March forced fruit bud development into the bloom period about two weeks earlier than normal.

Codling Moth

First brood codling moth was easily controlled as a result of favorable weather conditions, light carry-over from 1947 and effective spraying with DDT. Second brood built up somewhat but commercial losses were not serious. Plot No. 15 which had six sprays of Ryania concentration (5 ounces per 100 gallons) beginning with the petal-fall spray and continuing through the fifth cover, gave excellent control of codling moth with only 2.6 percent fruit injury. Parathion and DDT were other outstanding materials.

Mites

Mite populations remained relatively low until late in June, when several heavy infestations of the European red mite developed and afforded good plots for acaricidal tests. Most infestations had disappeared by July 15. Red spider mite populations remained light except on peaches where several serious outbreaks occurred late in July and in early August.

1/ These investigations were carried on jointly by the Bureau of Entomology and Plant Quarantine and the West Virginia Agricultural Experiment Station.

Extensive control tests indicate that several new materials are effective in the control of European red mites. Parathion appears to be outstanding. Results indicate the minimum effective dosage is about 4 ounces (actual) per 100 gallons. CR-1639 was one of the more effective materials tested for the control of mites. It gave effective control of European red mite at concentrations as low as one pint of the liquid or one pound of the powder per 100 gallons. It caused some foliage injury, however, when used at higher concentrations in certain blocks during late season. DN-111 was the most effective satisfactory material tested that is readily available for commercial use. It gave more satisfactory results than tetraethyl pyrophosphate products now being recommended and widely used in commercial orchards. Results of our tests indicate that the minimum effective concentration of DN-111 lies between 10 and 15 ounces per 100 gallons. Dimite gave good regults when used at concentrations as high as one pound per 100 gallons. Neotran was very effective in the control of mites at a concentration of 2 1/4 pounds per 100 gallons, but caused severe fruit russeting and foliage injury. Toxaphene was very toxic to mites at a concentration of one pound of toxicant per 100 gallons. Injury from toxaphene used on peaches, however, amounted to 100 percent dropped fruits.

Red-Banded Leaf Roller

The red-banded leaf roller has suddenly become the most destructive insect pest of apples in the Cumberland-Shenandoah fruit belt. Damage in individual orchards ranged from light to very severe. A general survey showed an average of nearly 50 percent of the entire 1948 crop to be damaged by the pest. Far greater injury would surely have been seen had it not been for the timely discovery of the extreme effectiveness of rhothane for the control of leaf roller larvae. Leaf roller populations began to increase soon after the introduction of DDT and its substitution for arsenate of lead in our spray schedule and have continued to increase steadily to the present.

There is some reason to believe that the outbreak is not entirely due to the use of DDT since the pest has readily been found in great abundance on practically all local types of vegetation, and in places far removed from areas where DDT had been used. This fact suggests the possibility that the outbreak may be cyclic and due to natural factors.

The outbreak was indicated early in 1948, by the large number of first brood moths caught in bait pails during the last week of March and the first week of April. Moth catch was heavy through most of April. In view of the threatened damage, extensive test plots were set up in heavily infested orchards.

Rhothane

Successful early-season results indicated that rhothane (DDD-dichloro diphenyl dichloroethane), toxaphene (chlorinated camphene) and parathion were extremely effective in the control of first brood leaf roller larvae. Other

materials including arsenate of lead and DDT were unsatisfactory when used at practical concentrations against heavy infestations such as those existing where the experiments were being conducted.

Rhothane has been tested rather extensively for control of other orchard insects but the results indicate that it is outstanding only for control of the red-banded leaf roller. The liquid form was the most effective material tested. The minimum effective concentration is about one quart per 100 gallons of diluted spray, but concentrations of one pint per 100 gallons gave some excellent results. About 2 pounds of the 50 percent wettable powder is required to equal one quart of the liquid concentrate. Maximum effectiveness of rhothane results from its control of the larvae; so it should be applied when the most larvae are present. Our results indicate that a single application properly applied will practically destroy any leaf roller population.

Liquid rhothane also gave excellent results in control of second- and third-brood larvae. In a full season schedule it was used at the rate of 3 pints per 100 gallons of diluted spray in the petal-fall and one quart in the first and second cover sprays before results were checked showing complete control. This schedule was continued with the use of one quart in each of the third, fourth and fifth cover sprays with continued effective control. Moth migration in single-tree plots tends to level off populations and mask effectiveness of differential treatments; however, rhothane was so effective that second brood records showed only 96 larvae and pupae for the five record trees. Harvest results showed only 0.9 percent of the fruit damage by leaf roller larvae.

The effectiveness of liquid rhothane appears to be due to its high degree of penetration. Where the effectiveness of other materials may be lessened by rapid vegetable growth, rhothane readily penetrates most webs and reaches the larvae in their protective shelters. In contact with the webbing rhothane seems to dissolve and lossen it. The larvae become active and a large percentage leave their protective shelters within a few minutes and drop from the trees on web streamers. Many remain suspended on their streamers for several hours, but none were able to regain the tree. They eventually drop to the ground but do not move far. Many remained inactive for several hours or days before dying, but those placed in jars with unsprayed foliage did not feed.

Rhothane was recommended for general commercial use and was used on several thousand acres of apples with excellent results. It appears to be safe for use on fruit and foliage and is compatible with most standard insecticides, acaricides and fungicides with the exception of DN-111. Its compatibility with sulfur in early season sprays was questioned but during the past two seasons it has been used with flotation sulfur in petal-fall, first and second cover sprays without definite indications of injury. Some plot trees showed slight chlorosis of foliage, but it was neither consistent nor definite.

Studies indicated that liquid rhothane is also toxic to adult moths. It seems to retain a high degree of residual toxicity to larvae for a period of ten days to two weeks following the application, depending upon the concentration used. It showed little toxicity to the pupae.

Toxaphene

Toxaphene has proven effective in the control of the red-banded leaf roller. The material used was a 40 percent wettable powder. It was used in a full season schedule of a petal-fall and five cover spray applications at the rate of 2 1/2 pounds per 100 gallons of diluted spray. Control counts following the second cover spray showed only 12 first brood larvae and pupae for the five test trees and counts following the fourth cover spray showed only 173 larvae and pupae present at the end of second brood activity. At harvest only 5.1 percent of the fruit showed leaf roller injury. The material did not injure fruit or foliage.

Parathion

Parathion was extremely toxic to red-banded leaf roller and many other orchard pests. It is the most toxic insecticide tested at our station. Information indicates it is extremely effective in the control of most insect and mite pests in our orchards. The material used in most of our experiments was a 25 percent wettable powder. Parathion was more effective in the control of first brood larvae than for those of later broods. Concentrations of one ounce of toxicant per 100 gallons in the petal-fall and first and second cover sprays gave excellent control of first brood larvae. There was slight increase in control with increases in concentration up to 4 ounces per 100 gallons. In the second and third brood, effective control appeared to be above 4 ounces. Repeat applications gave slightly increased control. Parathion seemed readily compatible with all other materials tested and there was no evidence of injury to fruit, foliage or cover crop.

Lead Arsenate and DDT

Lead arsenate controlled second and third brood larvae much more effectively than it did first brood larvae. Later in the season growth rate is slower, and foliage can be kept well covered with less difficulty with the result that such materials as lead arsenate are more effective in later season sprays. The standard lead arsenate-DDT schedule consisted of 3 pounds of lead arsenate in the petal-fall and first and second cover sprays and 2 pounds of DDT, 50 percent wettable powder, in the second to fifth covers inclusively. Counts following the second cover spray showed 66 first brood larvae and pupae for the five record trees and similar counts at the end of second brood activity showed 111 larvae and pupae present. At harvest 16.4 percent of the fruit showed leaf roller injury. DDT is fairly toxic but minimum effective concentration for second and third brood larvae

seems to be about 3 to 4 pounds actual DDT per 100 gallons. It controlled first brood larvae more effectively than second or third brood. The reason for this appears to be due to the fact that first brood eggs are laid chiefly on tree trunks and main scaffold branches; thus newly hatched larvae must often crawl considerable distance to find foliage on which to feed. During this stage DDT residues are apparently effective. DDT is also toxic to adult moths.

To show relative toxicity of above materials in leaf roller control in the same experiment, one plot received a full schedule of a new dinitro compound. Counts from this plot following the second cover spray showed 597 first brood larvae and pupae for the five record trees and similar counts at the end of second brood activity showed 1078 larvae and pupae present. At harvest 82.6 percent of the fruit showed injury by leaf roller.

Cumulative Soil Toxicity

Significant results have been obtained in an experiment designed to determine the toxicity of cumulative spray residues in the soil. Ten materials are being tested at three concentration levels; normal concentration, 10 X concentration and 30 X normal concentration.

The maximum concentration of 1200 pounds of (actual) DDT per acre did not show any toxic effect to either the rye cover crop or to the weed seed germination or weed growth. At this concentration the vegetative growth showed slightly better color and more vigor than that in the check plots.

The maximum concentration of 150 pounds of (actual) parathion showed a very marked stimulation to the cover crops. The vegetative growth was definitely more vigorous and the color better than in any of the other plots in the experiment with the possible exception of chlordane.

The maximum concentration of 6-8-100 zinc-bordeaux (7200 pounds zinc and 9600 pounds of lime per acre) showed a slight stimulating effect on the grass cover crop.

The BHC treatment showed definite toxicity at all concentrations. The rye cover crop showed definite chlorosis and stunting at the normal concentration of 8 pounds of the gamma isomer per acre. This light concentration was also toxic to weed seed germination and weed growth. This toxicity was more pronounced in the X 10 and X 30 concentration plots. The toxicity was so pronounced as to make the commercial use of this material quentionable.

Lead arsenate showed very little toxic effect even at the concentration of 3600 pounds per acre.

In sulfur plots both the X 10 and X 30 concentrations showed definite toxicity to both rye and weed cover crops. In the X 10 concentration block sulfur was used at the rate of 2500 pounds per acre and in the X 30 concentration block it was used at 7500 pounds per acre.

Fermate showed a definite stimulating and invigorating effect both on rye and weed cover crops. The maximum concentration of this material was 2250 pounds per acre. The stimulating effect appeared to be in direct ratio to the amount of fermate applied.

Both the X 10 and X 30 concentrations of chlordane produced a stimulating effect on the rye cover crop but the X 30 concentration showed early toxicity to weed seed germination but later crab grass and foxtail grasses developed and produced very luxuriant growth.

In the X 10 concentration block chlordane was used at the rate of 400 pounds (actual) per acre while in the X 30 block it was used at the rate of 1200 pounds per acre.

The maximum concentration of 400 pounds of (actual) toxaphene per acre did not cause any apparent toxic effect to either the rye or weed cover crops.

No treatments have yet shown any apparent toxic effect in either the apple or peach trees. Tree growth records indicate that the lighter the weed cover crop, the more vigorous the tree growth.